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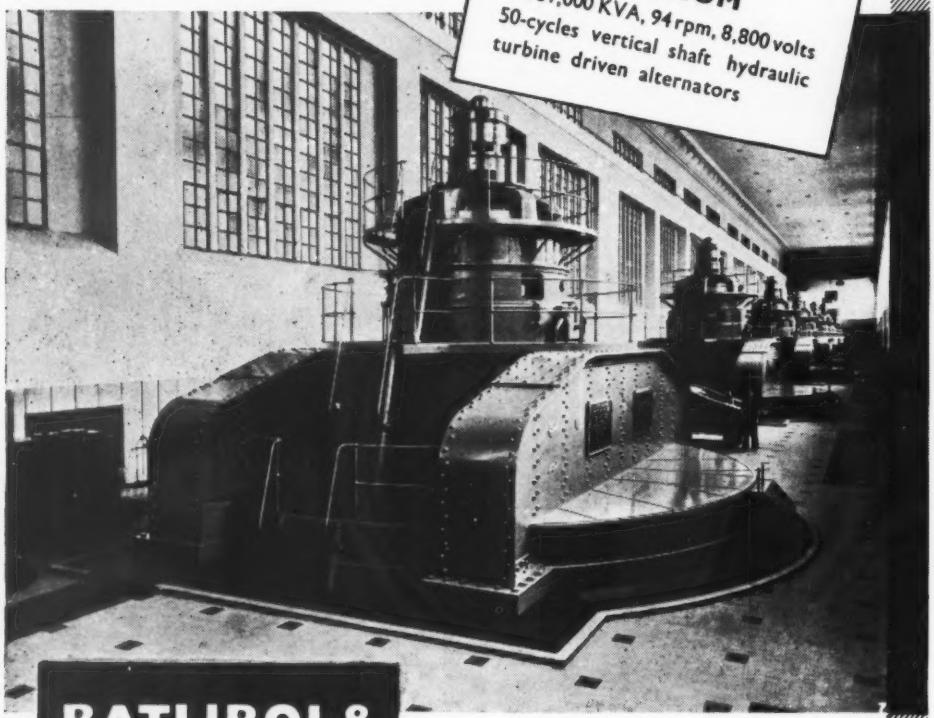

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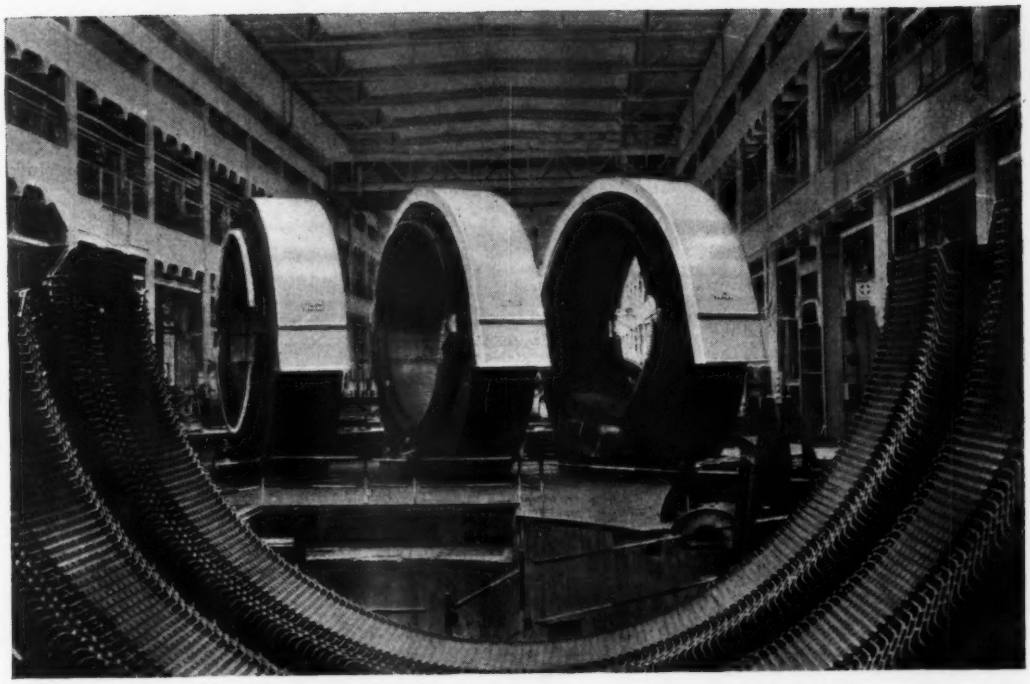

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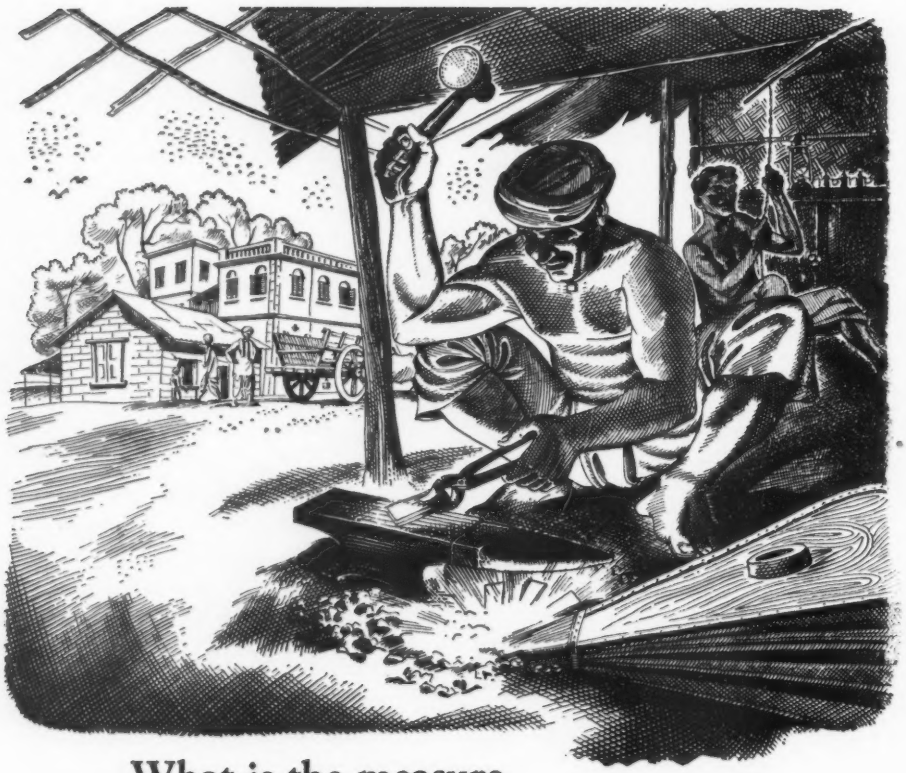

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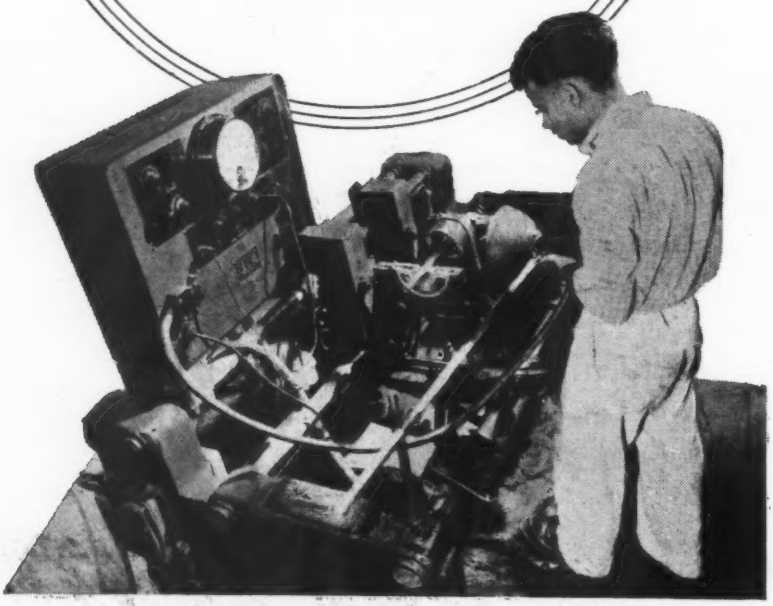

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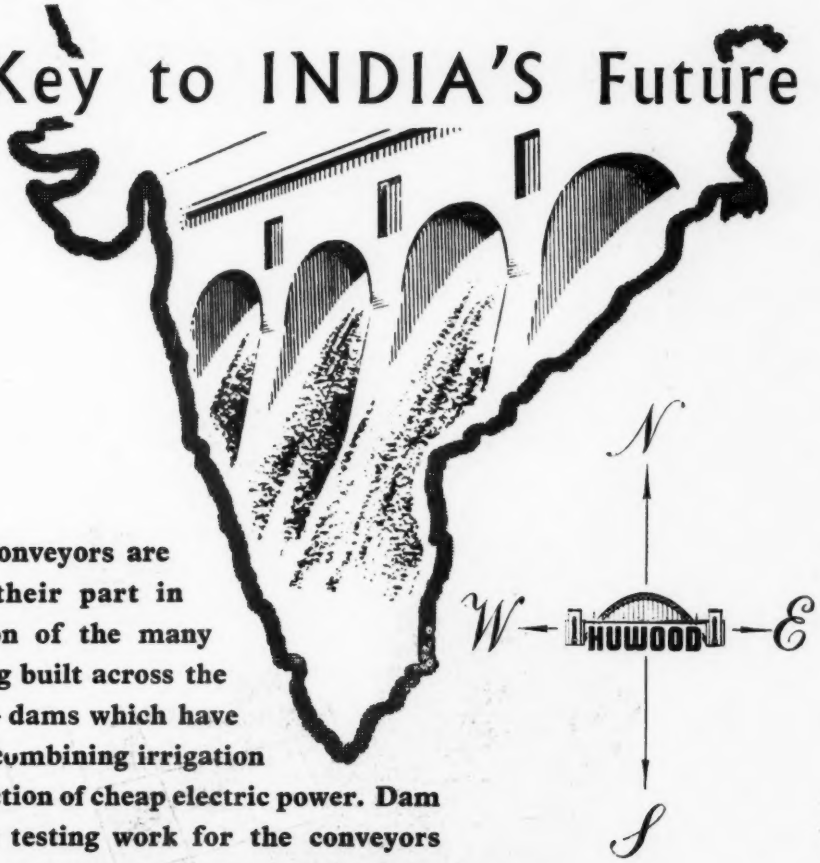

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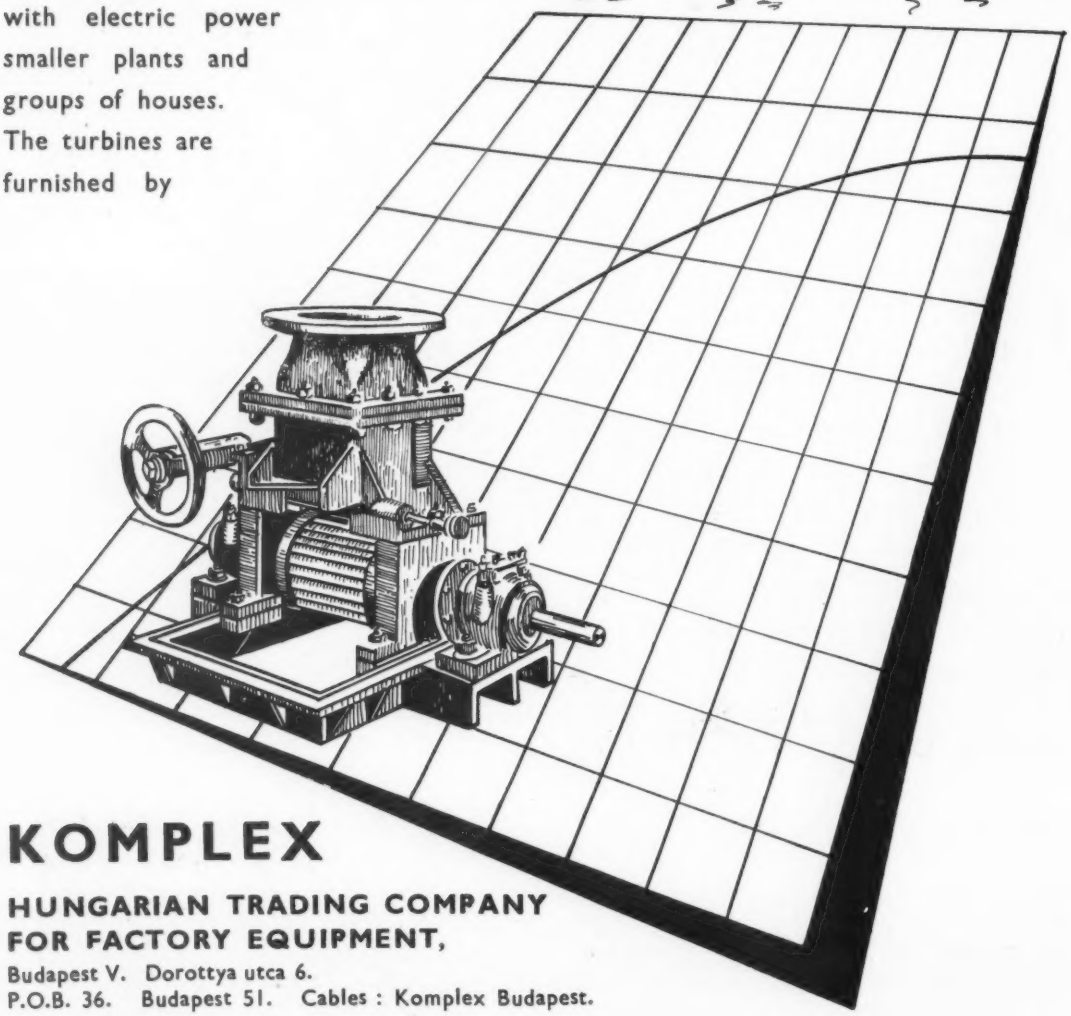

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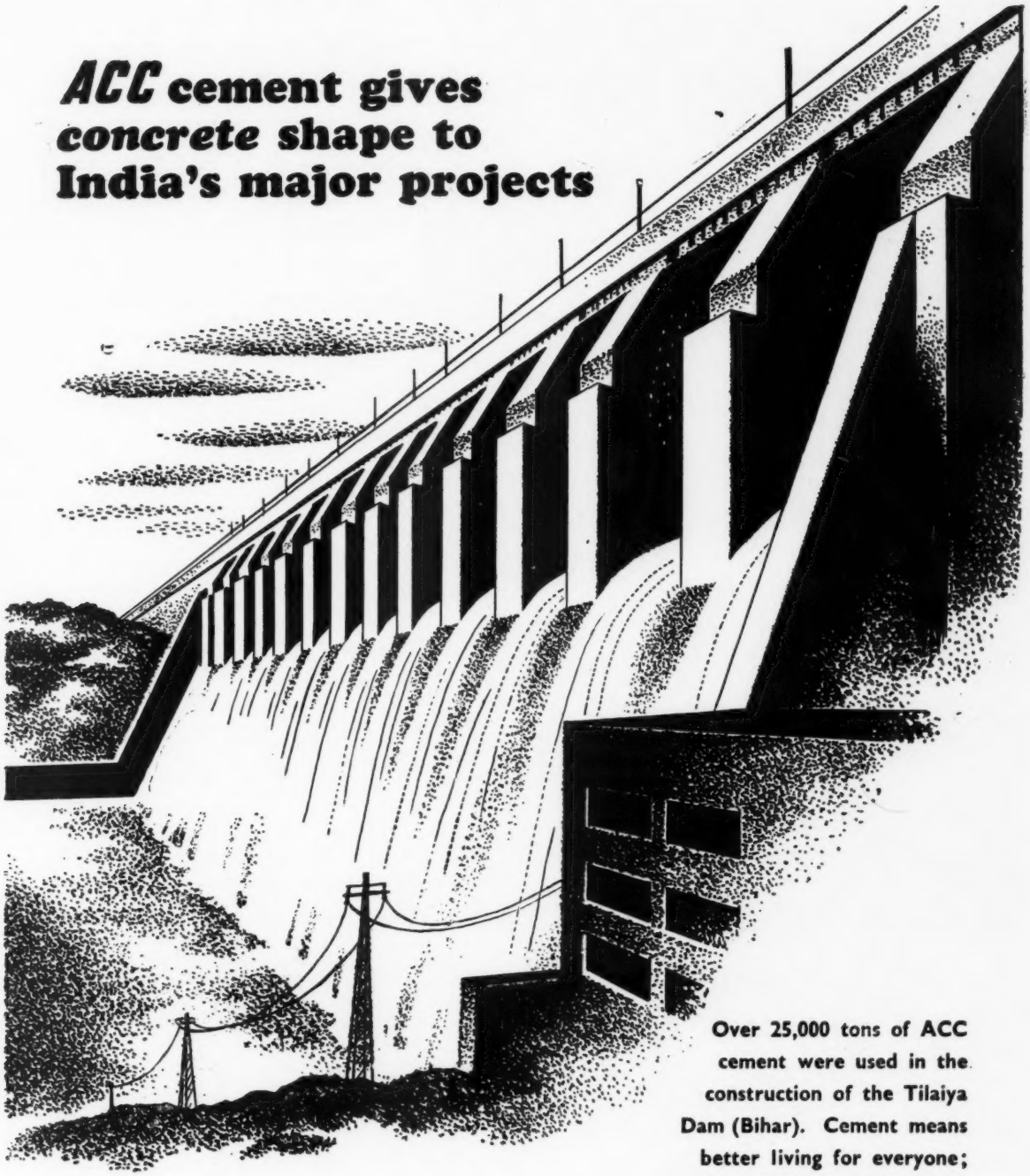

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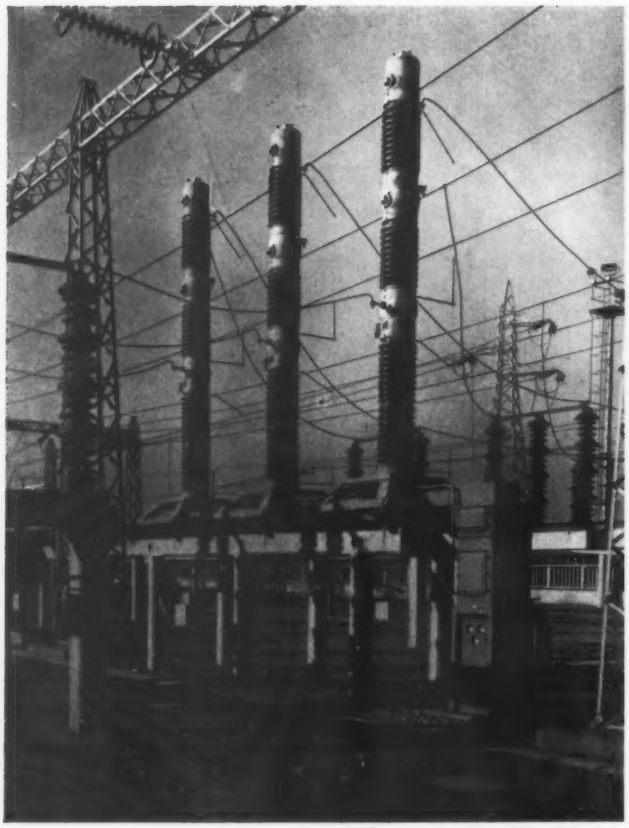

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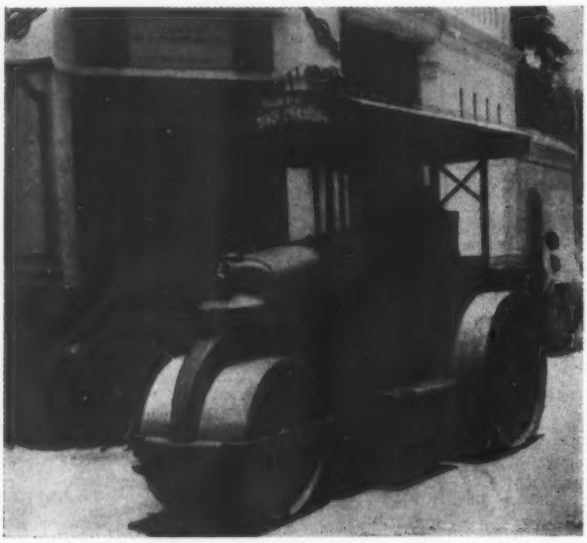

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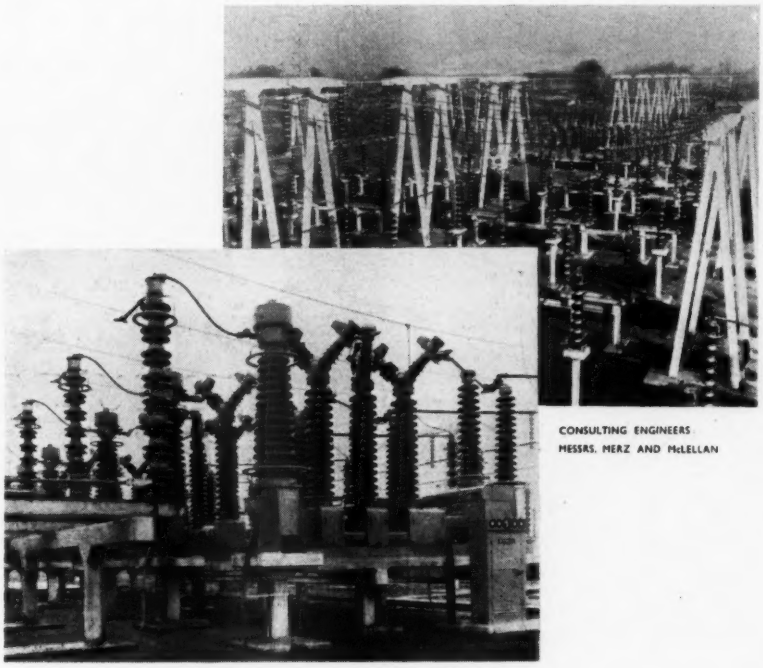

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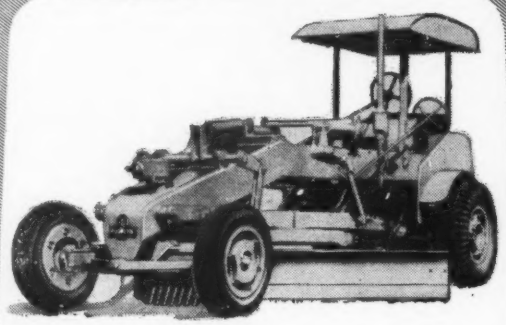

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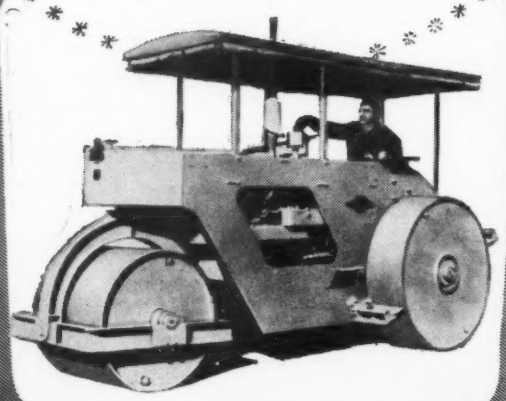

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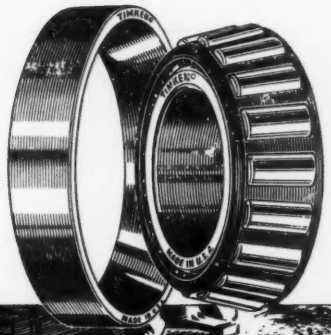

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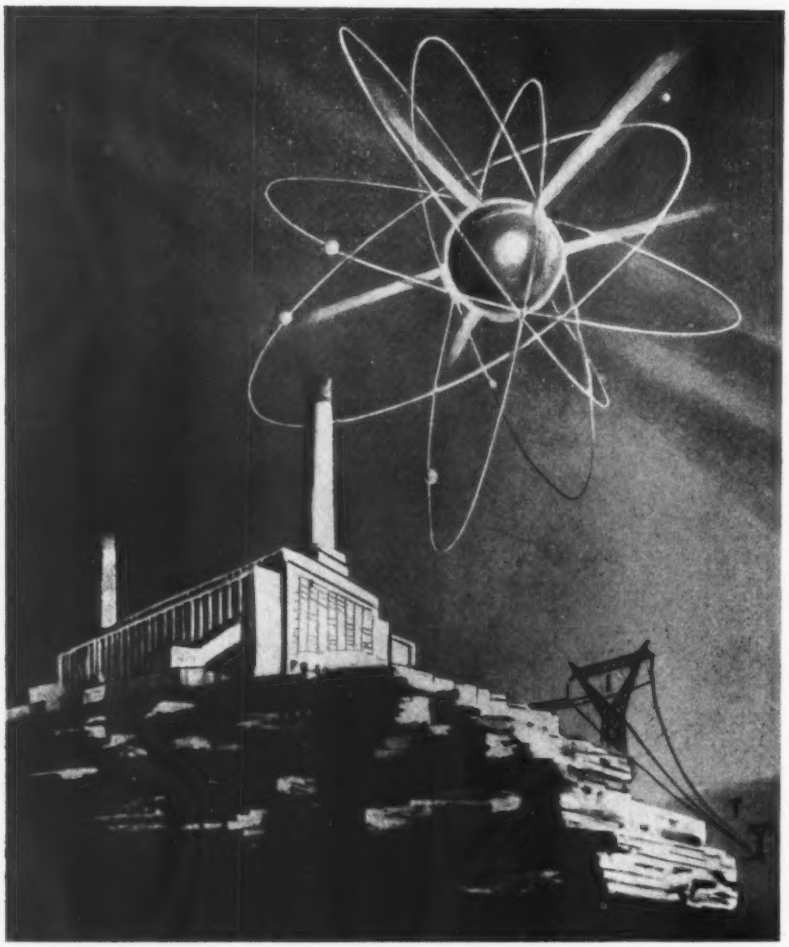

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Editor : K. K. Sinha

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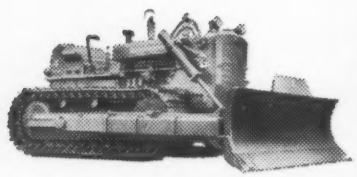
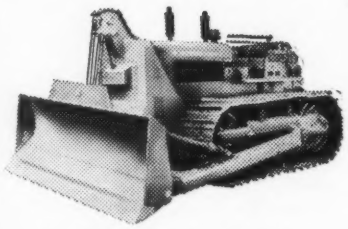
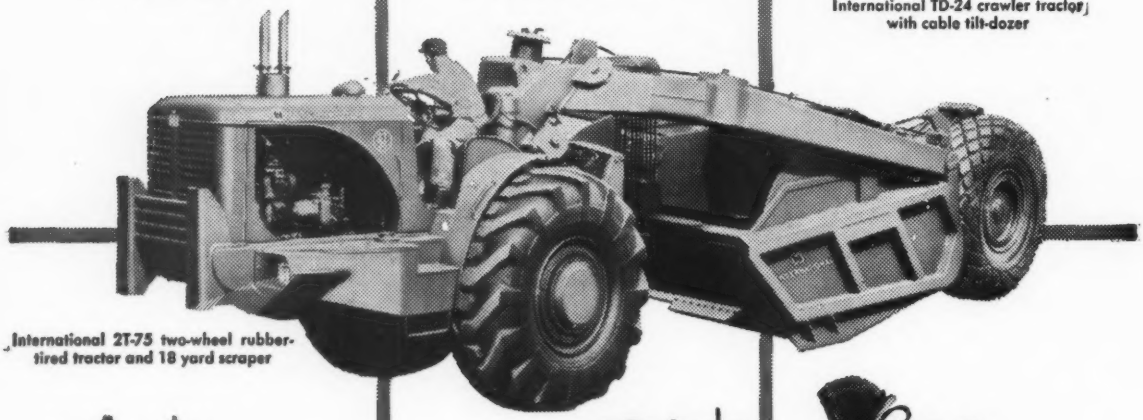


International TD-24 crawler tractor with hydraulic bullgrader

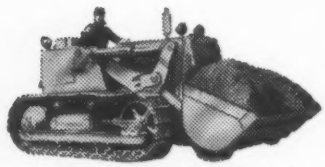
International B-250 four-wheel scraper for use with the TD-24 tractor



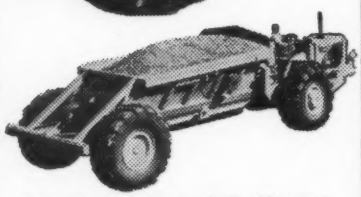
International TD-24 crawler tractor with cable tilt-dozer



International 2T-75 two-wheel rubber-tired tractor and 18 yard scraper



International TD-14A crawler tractor with hydraulic skid-shovel



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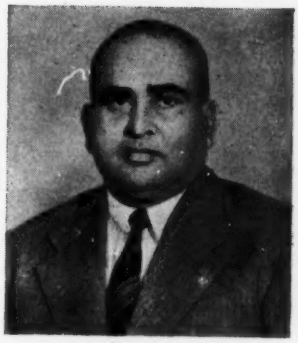
A. R. VENKATACHARI, I.S.E., M.I.E., M.A.S.C.E.
Chief Engineer, P.W.D. (Madras)(Retd.), Padma-Bhusan



AUTHOR

A large number of dams have been built all over India in recent years. Many more are under construction and still others are to be taken up in the near future under the Second Five-Year Plan. Most of them have more than one object in view : storage for irrigation, power, flood control. A few will also serve navigation and provide facilities for water transport. A good deal of experience has been gained in the construction of these works in the last few years and some of the difficulties which the Engineers had to face in the early years following the termination of the World War and dependence of India are now matters of history.

Material of Construction

In the early years several matters of importance had to be considered. The older dams were mostly of stone masonry in lime surki mortar. Cement mortar with an admixture of surki was first used in India on a large dam namely Mettur Dam across the Cauvery river in South India about 25 years ago. There was a great deal of controversy about the relative advantages and disadvantages in the use of lime, surki, and cement at the time Mettur Dam was built but the final decision was in favour of cement with a samll admixture of surki (burnt brick ground in mills to a fine powder). This practice is still largely followed in Madras, the surki being used in varying proportions in some places and omitted in others according to circumstances. Madras has available a large number of stone masons accustomed to work on masonry dams and this factor has been responsible for the almost exclusive choice of stone masonry in high dams. Stone masonry using stone as quarried without crushing and grading and less quantity of the comparatively costly ingredient cement gives a form of construction cheaper than concrete. If the faces are built in coursed rubble or stone dressed in one or more lines, and pointed with cement mortar of suitable proportions, it makes a very satisfactory and water tight structure. Cement concrete has not therefore been used to any extent in South Indian Dams. One point in regard to a masonry dam is here worthy of mention. A masonry dam has to be built by stone masons standing over or by the side of the masonry work, and the progress on the work is therefore limited to the number of workmen that can be accommodated in the length and breadth of the dam under construction at any time. A long dam on which a large number of men can work at a time would obviously afford the maximum facilities for such construction. In the case of concrete dam where concrete is made and placed mechanically this difficulty does not arise.

The all concrete dam in cement is more generally adopted now-a-days in North India for various reasons, one of the chief reasons being the paucity of stone masons used to the type of masonry used on stone dams in South India. The concrete type of structure is generally more costly involving as it does processing of aggregates and more of cement. While concrete has been used in many of the North Indian dams, it will nevertheless be observed that where time schedule permitted and the initial difficulties attending the use of stone masonry had been overcome, the stone masonry form of construction has been used and chiefly built with the help of stone masons imported from other States particularly South India.

Again in the early days of dam construction masonry or concrete was almost exclusively used for all high dams, the height of earth dams being limited to 60 ft. and less. Following the practice in America and elsewhere earth dams of great heights have now come to occupy a leading place in all modern forms of dam construction. An earth dam to serve the purpose nearly as well as a masonry dam can now be built without difficulty and is besides economical in first cost. A well balanced design with masonry and earth dam sections can also make for optimum use of the local materials leading to over-all economy in the entire dam structure. Thus stone quarried and not useful for masonry can be used for the rip rap or filters in an earth dam. Earth dams of great heights have been very successfully built in U.S.A., and many have been built in both South and North India in recent years. The essence of such construction is quality control of the elements making an earth dam based on field and laboratory tests. Moisture control and consolidation to prescribed densities are essential features. Initial difficulties of design and construction have all been overcome with the experience gained in the last few years so that in suitable locations and given suitable materials, earth dams of large heights can be suitably designed and built in India at the present time.

A type of dam for which there is a great deal of

scope in the coming years is the type known as rock fill with an impermeable earth core and base of dimensions suited to the type of base material. There is a general tendency to avoid this form of construction but in certain locations particularly where earth is difficult to get in adequate quantities and bouldery rock is available in quantity such a dam will be about the cheapest form of structure. Great care is necessary in building such a dam so that its settlement when the reservoir is filled with water, is kept at a minimum and as designed, and provided for during construction by suitably increasing the margins and free board. The earth core and base should be carefully consolidated and the stone shoulder should be properly filled with coarse aggregate and compacted by sluicing, vibrating and rolling. Some work of an experimental nature to determine the most suitable form to be used in such construction would appear to be necessary. It has been stated that some of the T.V.A. Dams built of rock fill in the above manner have proved satisfactory. The important thing about this type is the development of a correct technique in their construction.

Place of Manual Labour

In regard to the constructional technique, it is obvious that in an underdeveloped country like India working on a subsistence economy, the need for provision of employment to all the available labour force, skilled and unskilled is the primary need. Whatever work can be done by manual labour at a cost lower than imported machine should obviously be done by it. There will be other cases where the cost by manual labour may be more than by machine. Another class where manual labour is less efficient than machine. For instance concrete or mortar mixed in a machine is far more satisfactory than mortar mixed by hand. While excavation of soft earth by manual labour and loading into wagons may not be so very costly, transporting the excavated earth over long distances or lifting it by more than a few feet above ground may be quite costly in time and money when done by manual labour. So on each project, each operation must be studied in regard to the quality, efficiency, time schedule, availability of labour, and classified as suitable for manual or machine labour if the use of the machine is justified. Other conditions being equal, a weightage should be given to manual labour which cannot otherwise find employment but where such preference for manual labour would add materially to the costs, the cost to be debited to the project should be limited to a reasonable sum and the balance needed mainly to provide employment found from other sources very much as is done in the case of famine or similar works intended to relieve conditions of distress and unemployment. It would not be fair to place the whole charge on the project in such circumstances. Incidentally it may be mentioned here that when mechanisation for any particular item of work is decided upon, the choice of machine should be made taking into account not only the cost of the particular machine but its overall cost in terms of reliable and dependable operation, maintenance, depreciation in relation to wear and tear of the particular machine and availability of spare parts and possibility of making them within the country without need for future imports. The recent attempts to tackle this question at the Engineers' Seminar should when they find an agreed solution provide a useful practical basis for working in future projects.

Agency of Construction

Allied to this subject is the method of construction to be adopted in building a dam. A great deal of discussion has taken place as to whether departmental method or contract method is best for the construction of a large dam. The departmental method is not the method of employing workmen on daily wages as it is sometimes assumed, but that of splitting the work into innumerable small piece or job work contracts in which a rate per unit of quantity is specified. The pieceworker is generally a headman with little capital at the head of a small gang of workmen doing a small piece of work, either quarrying stone, collecting sand, or building masonry in which last case the stone and cement mortar is collected by other piece workers, transported and processed by the department and supplied to masonry piece workers. The method does not preclude the employment of bigger contractors for clearly defined portions of work in a dam not subject to modifications during execution. Supply of small and heavy tools and plant, machinery where necessary, cement etc. are generally made departmentally. As against this departmental method there is the overall contract method in which a large firm of engineering contractors with experience in dam construction is employed on a larger contract. Both methods have been advocated and used on construction of dams, the former method being very commonly used in South India and also in many places in North India.

Constructional details in dams are so many that it is impossible to do justice to so vast a subject in a small article. Besides these vary very considerably from place to place and from time to time as science advances. As illustrations of these problems may be mentioned : the design and construction of river and canal sluices in dams with suitable inlet and exist flumes and dissipation of energy devices, the design and construction of spillways for flood disposal with arrangements for dissipation of energy downstream, and design and construction of most efficient types of shutters for sluices and spillways. The mass sections and masonry dams together with inspection and drainage galleries in the masonry dams, the design, embedment of stress and strain gauges are some of the other features of design and construction which need careful design and execution. The preparation of foundations for earth and masonry dams, effective grout crutains, and cut-off and key trenches, protection of slopes against erosion, efficient drainage are also some of the important features.

Silting of Reservoirs

The silting and life of reservoir is also a matter of interest to most Engineers. Conditions vary so greatly from river to river and even in diffierent reaches of the same river that it may be difficult to be definite about the utility of various devices such as soil conservation which may be used to reduce silting and prolong the life of a reservoir. With his limited experience the writer considers that the provision of deep river sluices in the bed of the river channel but some feet below the level of the river margins as they stood before dam construction (within the cross section of the river channel) is useful in maintaining a flow of silt laden water (density currents) along the old river course, provided the sluices are kept open most of the time and carry a significant volume of discharge. This continuous operation is particularly

necessary when silt laden waters are entering the reservoirs during floods. The operation of these sluices in the manner stated induces a flow along the old stream course with the reservoir bed carrying the silt even when the top water is comparatively still. In some reservoirs in South India, it has been observed that during floods the water issuing through these sluices is definitely red and silt laden though the surface water is clear. Visual observation over the bed of Mettur reservoir in one of the most serious drought years (1946) showed little silting in the reservoir in the vicinity of the dam structure, and the deep sluices, though the dam had been in operation for about 15 years. This statement should not be taken to mean that there is no silting in the reservoir at all particularly at the upstream junction of the river and the water spread where silt may first be expected to deposit. Observations in these areas have not been taken as yet, so that it is difficult to say what is happening there. The area is some what difficult of access. However the fact that red water is discharged through sluices in flood periods would serve to indicate that some of the bed and suspend silt does find its way through the reservoir water spread along the river channel down to the sluices. It is therefore the writer's opinion that suitable number and capacity of sluices should be provided in all dams which bring in silt in the old river channel section (or connected to it by an artificially excavated channel) and such sluices should as far as possible be operated continuously to pass a sizeable discharge to minimise silting trouble in reservoirs.

Criteria of Selection of Projects

The criteria to be applied in sanctioning a dam project are often the subject of considerable criticism. In the old days, the criterion of productivity i.e. that the net return on a project should repay the interest charges fully on the funds borrowed for its construction was rigorously observed. The acute food problem following on the outbreak of war and termination of all food imports could only be solved by imports of food at considerable expense from far away countries in the years following the end of war and the declaration of independence. Other considerations then came into the picture. It was obvious that food grown in the country not only made for self-sufficiency but was also cheaper than food imported. So the State had to play a part not only in looking to an adequate return on a project but also to prevent recurring losses on imports of food needed to feed the population. It came also to be realised that a State was benefitted not only by direct returns on a project but also was benefited by the increased wealth with owners and cultivators in a project area, increased trade, commerce and transport, and higher incomes generated in a project area following the execution of a project. A more liberal policy is now being followed as a result in according sanction to new projects. It will be seen that these indirect returns to the State can be very considerable. Suppose a project is executed at a cost of say Rs. 500/- per acre, the annual value of food on that acre after the completion of the project may well be also Rs. 500/-. Though the direct net return to the State may be only say Rs. 20/- per acre and net return to the owner Rs. 150/- per acre as against probably Rs. 50/- (for an unirrigated crop before the project subject to large variations due to uncertainties of a freakish monsoon), the balance (Rs. 500/- minus Rs. 170/-) is also spent on the community by way of labour wages employed either for reclamation or for cultivation and manures. Thus the employment potential is increased in many sectors and for all time and the State's and people's liability to feed the unemployed and distressed reduced proportionately. So an irrigation project makes a much larger impact on the country's economy than is sometimes realised.

A dam project need not be confined only to irrigation. Generation of electricity is now-a-days an almost a common feature in all dams. Electricity projects are generally more remunerative than food projects as they have an industrial potential, and in a sense similar to return on commercial crops grown on land like cotton, oilseed, sugarcane, etc. The combination of irrigation and electricity makes a project more attractive while the cost of the dam is not doubled by the twofold purpose it serves. The addition of flood control serves to reduce flood submersion and losses in years of heavy floods and serves also a humanitarian purpose. The returns on this part may not be quite so attractive. Inclusion of a Navigation element provides water transport facilities which co-ordinated with other forms of transport by rail and road may help the community to transport the produce of forests and land to market places at a cheaper cost. The return on this may not be quite attractive except in certain localities where river transport is already well established and people are used to and prefer this cheap method of transport. A multipurpose project with all these features is on the whole a more useful work for the community than a mere food project and the direct return on such project may if at all better than worse compared to a purely food project.

Financing Policy

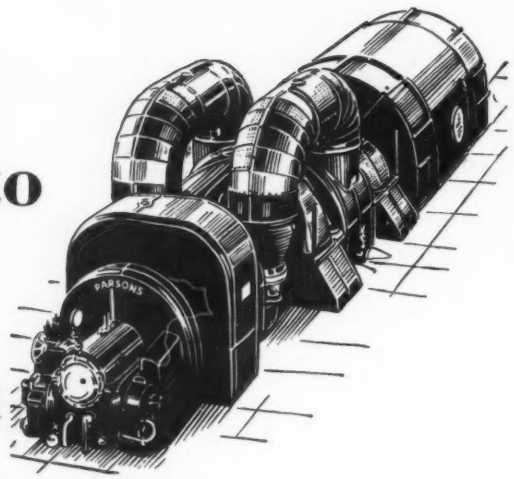
The policy in the matter of financing such projects arises in the light of the considerations set forth above. In regard to the first and old test of direct return, this return is based on the estimated cost of a work, the net revenue realisable (after working expenses). A further requirement might in the opinion of some financiers be that the capital outlay should be repaid to the State, the idea being that the project should pay not only interest on loan but also an annual sum to redeem the loan in a period of 20 to 40 years. In all these calculations, a possibility of prices rising and estimates needing revision as a result of essential modifications during execution should be kept in view.

The following otherconsiderations are also relevant. A project usually benefits part of a State and not the whole of it. The wealth and income it generates are confined to the benefited tracts though due to migration of labour some other parts may benefit in the sense that they may be relieved of the duty of looking after the migrated labour which was originally in residence there. A certain portion of profits of trade and commerce is not necessarily confined to the area benefited, as merchants dealing with the commodities may live in other parts of the State and even outside the State. But nevertheless the bulk of the income generated will lie within the benefitted tract. The State has a budget for the entire State and it therefore owes it as a duty that the cost of a project is laid

(*Contiuued on page* 10)

C. A. PARSONS

Largest Supplier to India of Steam Turbo-Generators



The present installed capacity of Parsons' Steam Turbo-Generators in commercial operation in Electricity Supply Cos., Government, Industrial and Railway Power Stations is as follows :

West Bengal	387,250 K.W.	Madhya Pradesh	15,500 K.W.
Bihar	117,500 K.W.	Andhra	12,000 K.W.
Uttar Pradesh	54,750 K.W.	Hyderabad	5,000 K.W.
Bombay	40,000 K.W.	Madras	4,000 K.W.

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Reflections on the Geneva Atomic Energy Conference

By
R. F. MASTERS
Editor, BEAMA Journal

AUTHOR

The Conference on the Peaceful Uses of Atomic Energy, which was held in Geneva in August, was a remarkable gathering in every way. Not only was it attended by 1400 delegates and their advisers, and by 3000 observers, from 73 countries, but the sessions were conducted in an atmosphere that can be described as truly international. Outside as well as inside the meetings there was a free and willing interchange of information between delegates.

The Conference thus dramatically lifted the veil of secrecy that has for too long hampered the interchange of scientific thought. That this secrecy was largely an illusion was shown by the fact that time and again delegates revealed experience gained behind locked doors, only to find that other countries had been travelling the same path. In the future the avoidance of this needless duplication of effort should lead to even more rapid advances than have been made in recent years.

Although specialists have been heard to complain that nothing much that was really new was revealed, the Conference has caused a great deal of information to be committed to print and it is thus more widely and easily available. Dr. Spence of Harwell is reported as stating that enough chemical data were revealed in one of the morning sessions by the United States, the United Kingdom, Canada, and France to enable any country to build a chemical processing plant for uranium fuel of 99 per cent efficiency.

Another remarkable aspect of the Conference was the vision and high sense of social responsibility displayed by delegates both in the paper and the discussions. Imagine a group of engineers at the end of the nineteenth century meeting to discuss the development of transport in the 1950's, their discussions ranging from the economics of different types of aircraft to the dangers of the fumes from diesel-engine exhaust in large cities.

In this article it is not possible to cover more than a fraction of the papers present, many of which are, in any case, outside the scope of this Journal. Nevertheless, it is hoped to provide some overall impressions of those sessions dealing with the world's need for a new source of energy, the economics of nuclear power, and the types of reactors to be used.

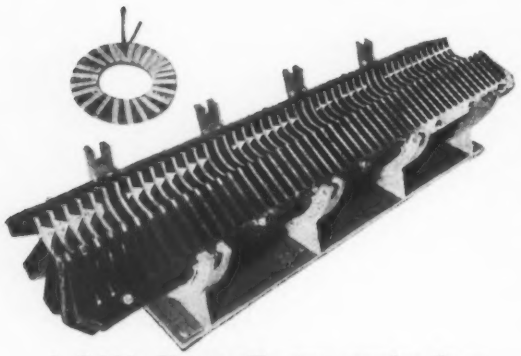
The uses and dangers of radioactivity

A significant part of the Conference was devoted to the general domain of radioactivity—not only the dangers but the great and increasing contributionsthat the use of radioactive isotopes render to medicine and industry. Dr. Willard Libby, of the US Atomic Energy Commission, truly said that nuclear research and development would have justified itself if it had never produced power but only those isotopes. His colleague, Mr. P. Aebershold, put the saving already achieved by the use of radioactive tracers in world industry at a thousand million dollars. Not only have they been used to study the nature of disease and the body process but also to unravel the mystery of photo-synthesis. Changes in plants can now be produced in five years which by normal breeding methods would take fifty.

Much attention was also given to the problem of extending the present international standards of radio-biological protection from the occupational workers, for whose safety they are designed, to cover 'the general radiation hazards problem of the world'. Speaking of the precautions taken in Britain, Professor W. V. Mayneord remarked that any atomic factory is probably the safest place to be in, and Sir Christopher Hinton, managing director of the UK Atomic Energy Authority, declared that a well-managed industrial nuclear power programme can be so operated as not to induce any problem of contamination by radioactive waste. Such wastes arise not in the nuclear power station itself but in the chemical plant in which the products of its reactors are later treated. In Britain it is intended to scatter the reactors all over the country, and the chemical processing will be carried out in not more than three factories which will be under control. Despite these assurances, it was generally agreed that the recommendations of the International Commission on Radio-biologic al protection should be incorported into world-wide codes of practice. In the words of a paper circulated by the World Health Organisation, 'this generation has an obligation to posterity to hand down the legacy of nuclear technology not only with its useful potentialities, but also with corresponding knowledge of how to deal with its inherent hazards'.

The World's needs for energy

The most important subject dealt with at Geneva



A British Thomson-Houston annular linear induction pump at an early stage of assembly.

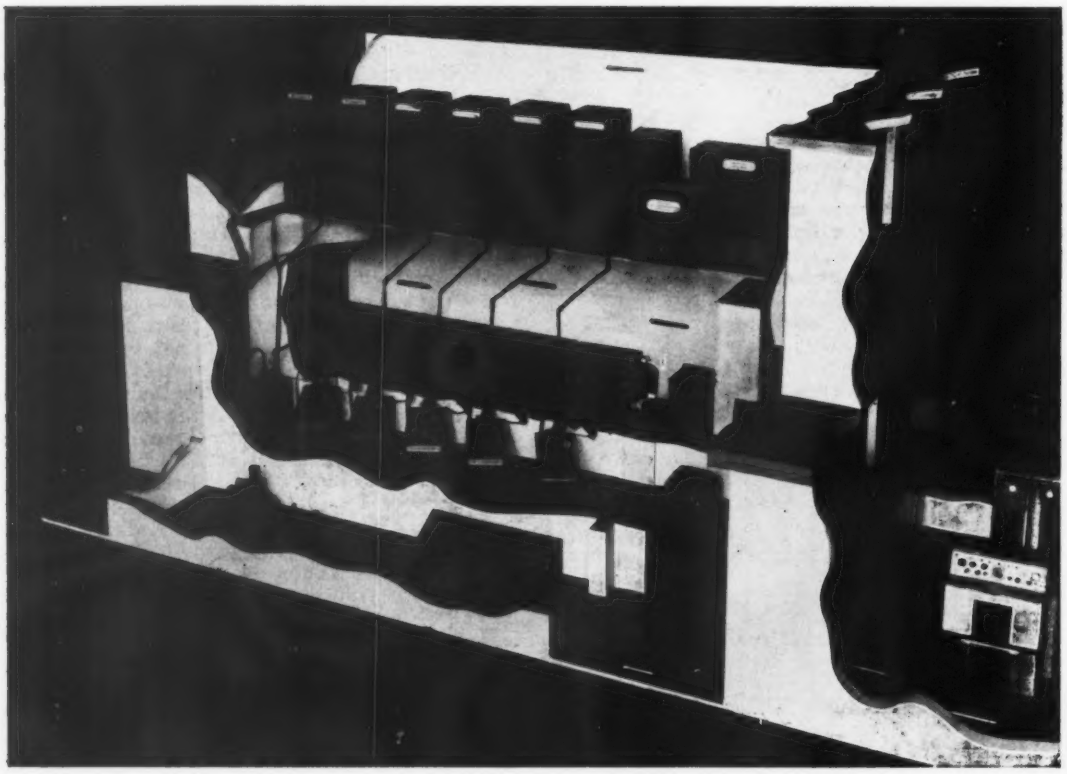
was undoubtedly the production of power by nuclear reactors, and this part of the proceedings received a strong practical emphasis from the simultaneous exhibitions in the Palais des Nations and Palais des Expositions. It will be many months before the vast amount of information presented at the Conference can be properly digested and assessed. But, nevertheless, it is already possible to see more clearly the pattern of future world energy demands and the ways and means by which it should be possible to meet them.

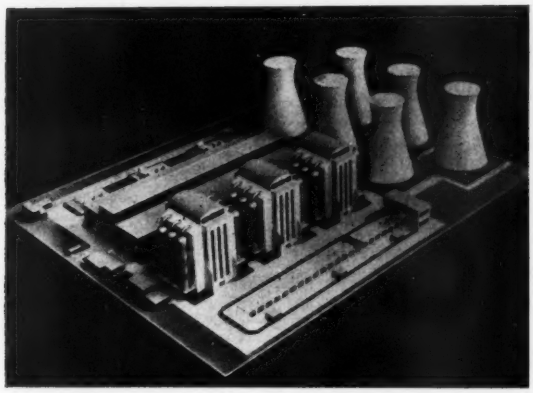
In his presidential address, Dr. Homi Bhabha, Chairman of the Atomic Energy Commission of India, saw the dawn of the atomic age as marking a change in the pattern of energy used by man compared with that introduced by the industrial revolution which was itself only the second great epoch since the emergence of the earliest civilisations. 'For the industrialisation of the underdeveloped countries, for the continuance of our civilisation, and its further development atomic energy is not merely an aid ; it is an absolute necessity.'

In the first eighteen and a half centuries of the Christian era consumption of energy was at an average rate of under $\frac{1}{2}$ Q a century. (Q=10^{16} B.Th.U.) By 1850 it was probably 1 Q a century. By 1950 roughly another 5 Q might have been consumed and the rate of consumption risen to 10 Q a century. Of this, 37 per cent was consumed in the United States, and if the entire present population of the world were to consume energy at the same rate a head, consumption would now be running at the level of $5\frac{1}{2}$ Q in ten years instead of 1 Q. Coupled with the doubling of the world's population in the next 100 years, which, Dr. Bhabha said, is the least that can be expected, this would exhaust known reserves of coal, oil, and natural gas within less than a century.

The more detailed estimates of the world's future

A model of a Metropolitan-Vickers linear accelerator under construction for the United Kingdom Atomic Energy Authority. The equipment will be used to provide a neutron source for neutron time-of-flight spectroscopy. (As far as is known, this electron accelerator will be more powerful than any yet built, since it is designed to produce an average beam power of 30 kW at an energy of 25 MeV. There will be six sections, each energized by a klystron amplifier operating at a wavelength of 10 cm and at 6 MW peak power. It will be possible to set the output pulse length of the accelerator at several values between 0.2 and 2 microsec. and the recurrence rate at values between 25 and 750 p.p.s.)





Model of a nuclear power station proposed by the General Electric Co. Ltd.

requirements of energy presented in the following session appeared at first to be conflicting. It turned out, however, that whereas the figures in the United Nations' paper were based on the rate of general development felt to be desirable, the British assessors, Messrs Robinson and Daniel, had sought to answer 'the cautious, canny and conservative question' of what was the least that might be expected. They pointed out that since the supply of energy is itself one of the principal factors influencing the rate of economic development, it is dangerous to use an argument which begins by forecasting world development and then attempts to estimate world energy demands from that assumed development.

The United Nations' paper forecast that by 1975 energy requirements will have increased to not quite three times the present level, and by the end of the century will have reached eight times. But because of greater efficiency in use, requirements in terms of fuel will have increased to between five and six times by the end of the century. The British forecast placed demand for energy in the year 2000 at between two and a half and three hand a half times the present consumption. Reserves of solid and liquid fuels and natural gas are of the order of 3500 tons of coal equivalent.

The need to supplement present sources of energy by a new source is, however, more urgent than is implied by these figures. For instance, whereas the trend of consumption has for nearly 100 years followed a remarkably steady path of about 2 per cent compound growth per annum, the world output of coal has been increasing by only about 0.5 per cent per annum. According to Robinson and Daniel, if these rates remain the same then, by the year 2000, out of a total demand of some 7½ milliard tons of coal equivalent, coal will supply 2 and hydro-electricity 1 milliard tons, the balance being made up by oil and natural gas. By 2025, 7½ milliard tons of coal equivalent will have to be supplied by oil and natural gas and the reserves of these two fuels will then be reduced to only about seventy years at the 2000 rate of use and about twenty-three years at the 2025 rate of use.

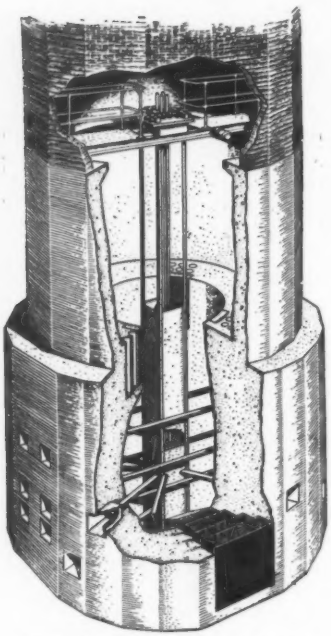
Our economy is, to a large extent, dependent on the products of oil and coal and, as Mr. J. M. Kay (UK) pointed out, the coming of nuclear electric power will enable the coal and oil resources to be used more and more as a source of chemicals and of liquid fuels. The development of water power, and also tidal energy, wind power, geo-thermal heat and the direct use of solar radiation, should always be pursued to the utmost because these are the only methods by which the world can meet its energy requirements out of income. The development of nuclear power will involve living on the world's capital resources, but the extent of this new fund is very great indeed and its exploitation will enable the more limited quantities of the fossil fuels to be conserved and put to the best possible use in future years.

The cost of nuclear power

Nuclear energy is not, however, a magic wand, and in his paper Dr. A. E. S. Mason (US) emphasised the large investment that will be needed to use the extra energy as well as to supply it, and he suggested that the most rapid development will be in those areas of highly developed countries where costs of energy are high. According to a United Nations survey, there are already many parts of the world where nuclear energy can compete economically with other sources of energy. Paper from some of the under-developed countries showed there will be a demand for power reactors developing about 10-MW of electricity.

The actual expenditure that will be needed in any country will depend on many factors, not the least of which is the amount of effort it is intended to spend on research and development. In a paper presented by Dr. S. W. Joslin (UK), it was pointed out that countries have three ways of equipping themselves with nuclear power stations. Some countries might wish to buy complete plants, the cost including the fuel and the return of the irradiated elements for processing. At present the cost would be about twice that of a normal station, but in a few years this should be reduced to one and a half times. Other countries might wish to build the station under licence from a proved design. Dr. Joslin warned that a sudden rush of orders for reactor materials such as graphite and heavy water might lead to serious shortages. The ancillary equipment could also be an important item : the construction of a diffusion plant could cost as much as the reactor itself. Finally a number of countries will certainly wish to rely entirely on their own resources, as the UK had been forced to do. This was a very much more expensive process, but the very fact that it involved research and gradual development within the country will probably be considered worthwhile in the end.

The estimation of the running costs of nuclear power stations is complicated : first by the fact that no power reactor has yet run long enough to enable its useful life to be judged accurately ; and secondly, by the value to be put on the by-product plutonium. With certain reservations there was, however, agreement between speakers from the United Kingdom, United States, and Russia that electricity generated in nuclear power stations is in early sight of being as cheap as or cheaper than electricity generated from coal or oil-fired stations. All three sets of figures relate to conditions in the country of the speaker. The American figures assume large-scale development fifteen to twenty years hence of the types of reactors now in the prototype stage and using substantially enriched uranium. The British and Russian figures,



Typical view showing the layout of the Research Reactor of A.E.I.—John Thompson.

on the other hand, refer to stations already planned or under construction and using natural or only slightly enriched uranium.

In his analysis Mr. J. A. Jukes of the UK Atomic Energy Authority gave the value of the electricity produced from the first stations to be built for the Central Electricity Authority as 0.76d. a unit. The cost of separating the plutonium produced should be a few pounds a gram and will fall with later development. Allowing for this cost, Mr. Jukes arrived at a net value for the plutonium of from £5 to £10 a gram. This would reduce the cost of electricity to 0.59d. or 0.43d. a unit. The latter figure, he thought, seemed more reasonable.

Choice of reactor

In contrast to the wide measure of agreement shown in the paper dealing with the economic aspects of nuclear power, the technical discussions on the choice of reactor system revealed a marked divergence of opinion. It is obviously too early to be dogmatic, and no doubt from the many types of reactor which will be tried in the next five or ten years a few types will be successful and will exist side by side as specially suitable for different conditions and applications.

The enormous difficulty in choosing a proper path for reactor development is evident from Dr. A. M. Weinberg's (US) calculation that it is possible from various combinations of the three main variables—fuel, coolant, and moderator—to build 900 or so different power reactors. Of these, about twelve have been selected for construction in experimental or prototype form in five countries. Thus, graphite-moderated reactors using gas, water, or liquid sodium for cooling are being built by Britain and France, Russia, and the United States, respectively. Reactors employing solid fuel and using light or heavy water as moderators are being studied in the United States and Canada in four types, both in designs in which the water boils in the reactor and in which a heat exchanger is used. At least three forms of homogeneous reactor are being designed and experimental fast-breeder reactors are being built in the United States and the United Kingdom.

So far, however, only two power reactors have been built and operated, these in Russia and the United States. The 5-MW Russian station, described by Professor Blokhinstev, uses graphite-moderated enriched uranium and the coolant is water under pressure. Although expensive in fuel it has proved very reliable in operation, and a 100-MW reactor is now being built.

The US reactor has an electrical output of 3500kW. It employs ordinary water as both coolant and moderator and uses enriched uranium as fuel. The steam is produced in the vessel containing the reactor, and is returned to the reactor after being led directly to the turbine and then condensed in the normal way. Although difficulties have been experienced in securing stable operation, mainly because of the presence of steam voids in the reactor core, the American authors were satisfied with the practicability and economies of such a plant. The Americans are also experimenting with some five other types of reactor. These form part of the US five-year programme of experimental and demonstration power reactors, which will be completed by 1960. By then the United States will be generating 800 MW of electricity from nuclear stations.

British plans

In Britain there is a greater need than in United States or Russia to develop nuclear power as a substitute for coal, and it is largely for this reason that although the Americans have pressed forward energetically on a broad front in developing the techniques of nuclear energy, it is probable that the first nuclear power station producing electricity in major and regular quantities for industrial consumption will be that which is under construction at Calder Hall.

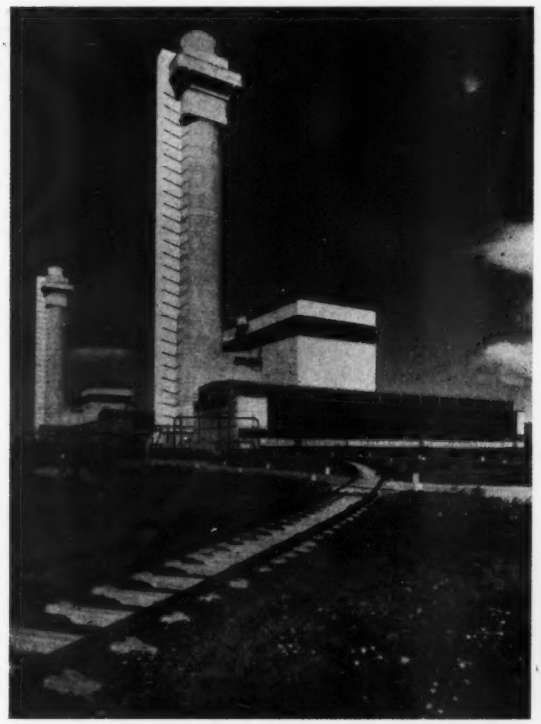
This station will consist of two gas-cooled graphite-moderated reactors and the heat will be transferred to steam generators by carbon dioxide under pressure. The station is expected to deliver over 50 MW of electricity to the national grid. It must be remembered, however, that the primary purpose of this station is the production of plutonium for use in later types of reactors and for military purposes.

The output and efficiency of the graphite-moderated nuclear power stations can be increased by increasing the pressure and temperature and improving the heat transfer characteristics.

Describing the contribution which nuclear power would make to UK energy resources up to 1975, Sir John Cockcroft, director of the Atomic Energy establishment at Harwell, said that British industrial organisations are now engaged on designing improved versions of the Calder station with technological help from the Atomic Energy Authority. The British Central Electricity Authority expect to build twelve of these power stations for successive completion between 1960 and 1965. The output of an individual

power station is expected to rise from 100 MW to at least 200 MW. The total installed capacity should therefore exceed 1000 MW by 1965, by which time nuclear energy will be doing the work of several million tons of coal a year.

After 1965, when industry has gained experience by construction and the Electricity Authority by operation of these stations, the programme is expected to expand much more rapidly until by 1970 most of the new British power stations should be of the nuclear type. By 1975 the installed capacity is likely to rise to between 10,000 and 15,000 MW, the total capacity of the public electricity supply system being then 55,000 to 60,000 MW. The nuclear power stations will probably be operated as base-load stations and so will supply a higher proportion of the power in relation to their capacity than coal stations. So by 1975 nuclear power should be doing the work of at least 40 million tons of coal a year—providing about 40 per cent of the energy for electricity.



The reactors at the Windscale Works factory, Sellafield, Cumberland. The two towers are over 400 feet high. The filters at the top of each chimney prevent the escape of any trace of radio-active matter.

In his paper describing the Calder Hall station. Sir Christopher Hinton said that he regarded this type of reactor as being in the same class in relation to future nuclear power plants as the reciprocating steam engine is to the gas turbine. It was chosen because it is safe, it requires only natural uranium to start with, and is within the capacity of engineers equipped with present proved knowledge of the operation of reactors. Sir Christopher said that it is reasonable to think of nuclear reactors in ascending scale of specific heat rating of their full elements. The Calder Hall reactors are at one end of the scale and fast fissions reactors, such as the one the UK Atomic Energy Authority were building at Dounreay, Scotland, are at the other.

The advantage of this latter type is that they produce more fissionable material (fuel) than they consume in maintaining the chain reaction. (It was revealed at the Conference that in the experimental fast breeder reactor—ZEPHYR—at Harwell the amount of plutonium created by the breeding method has been double that consumed in the reactor.) The problems involved in their construction are, however, formidable. For example, in order to achieve the very high rating required for economic reasons, it will be necessary in the Dounreay reactor to remove some 100 MW of electric power from a core 2 ft. in diameter by 2 ft. long (61 by 61 cm.) This would be achieved by using liquid metals as a coolant.

The United Kingdom, Sir Christopher Hinton continued, is not only attacking both ends of the scale, but in between these two extremes is applying her resources at those intermediate points which, from time to time, appear to offer the greatest promise.

He maintained that the development of highly rated reactors is essential because such reactors are needed to burn the by-product plutonium produced in the reactors of conservative rating which are built as the first step in our industrial programme. It would, however, be a great mistake to assume that these conservatively designed reactors of the graphite-moderated gas-cooled type have only a limited future. With development, the reciprocating steam engine held its own over a period of nearly 200 years as an economical prime mover, and the simplicity and reliability of the gas-cooled reactor will entitle it to a similar place in the history of nuclear power.

The lead which the papers and discussions showed the United Kingdom to have established in the practical applications of nuclear energy was even more

An artist's impression of Britain's latest atomic power station which is to be built at Dounreay in the north of Scotland. The dominant feature of the plant is the steel reactor sphere, which is 150 ft. in diameter and some 35 ft. above ground level. In the steel sphere, which is essentially a pressure casing, Britain's first power breeder reactor will be operated experimentally; it is expected to generate electricity by producing steam to drive conventional machines by creating more "fuel" than it consumes in the process; hence the term "breeder reactor".

strikingly demonstrated in the variety and extent of the equipment being shown by British firms in the commercial exhibition at the Palais des Expositions. This applied particularly to the impressive stands of those groups of civil, mechanical, and electrical engineering concerns which have been formed to undertake the design and construction of complete nuclear power stations, and which, as a result of the inquiries received at Geneva, are now studying several projects for oversea countries.

According to a recent Government publication which admirably tells the story of this country's past and present contributions to nuclear technology, over 150 firms have either undertaken work for the UK Atomic Energy Authority or are manufacturing nuclear instruments. As the United Kingdom's power programme gathers momentum, industry's participation and experience in this new field will grow rapidly. Industry will then not only be helping to satisfy the steadily mounting demand for electricity at home but will increasingly be able to help other countries in her traditional role of an exporter of skill, technical knowledge and equipment.

(*By arrangement with the BEAMA Journal*).

(*Continued from page* 3)

India's Practices and Policies in Dam Construction

on the areas in a manner and in proportion to the benefits derived from the project by the various parts. So the part directly benefited must necessarily bear a larger proportion of the cost and should therefore pay a larger tax than an area partly benefited or not benefited at all. There is likely to result in practice a conflict between the interests of the direct beneficiaries and the State representing the whole State (including beneficiaries) a position in which a correct decision is generally difficult to formulate.

As to whether a decision is correct in a particular case or not can be judged by one ultimate test. This is to regard the State and the people as one unit. If the outlay on a project, which is money spent on people (assuming none of the expenditure is incurred outside the State or country) is returned to the people by way of new incomes in amounts larger than the amounts spent by the State, then there is bound to be a continually and annually growing increase in wealth in the community. If the State does not get its share, it can increase its burden of tax and derive the necessary resources to pay interest and redeem the loans. In other words the money borrowed by the State from its people for the project can be paid back by the people in the shape of taxes. It is only where there is no substantial increase of wealth due to a project, that a project may become a burden on the present and future communities.

Most well-conceived and executed projects regarded in the above light will be more than justified by the overall returns on such projects. The difficulty is in the correct appraisal of the various values and the conflict of interest of different sections of the community in a democratic set up. While the task may be difficult, it nevertheless seems possible to arrive at reasonably sound decisions in regard to particular projects after making a comprehensive assessment of the full potential of the projects.

(*Continued from page* 18)

Floods and Flood-Control—With special reference to Bombay State

12. Summary and Conclusion

12.1 The paper gives a definition of the term 'Flood' which is considered in relation to flood control and measures adopted so far and required to be adopted hereafter. It discusses the different types of floods, their magnitude and measures adopted here and abroad in controlling heavy floods, and indicate the merits and limitations of providing the retarding and detention types of reservoirs in foreign countries.

12.2 Although no cases of huge floods with consequent heavy damages occur in the Bombay State, the problem as they exist, have been brought about in a nutshell indicating the major details of the different river valleys of the State and the extent of damages that have occurred during 1946-55.

12.3 The damages were haevy in the following river valleys.

Name of Valley	*Damage in lakhs of Rupees*
(1) Bhima	34.96
(2) Krishna	29.66
(3) Godavari	27.55
(4) Tapti	26.56

The above figures refer to direct damages due to heavy floods.

12.4 Heavy losses of indirect nature are inflicted on the public which are not included in the above figures. An outline to work out the indirect heavy losses has been given with a view to decide the feasibility and economics of Flood Control projects.

12.5 Floods control is one of the important problems of the main issue of River Behaviour. Other problems connected with this issue are also discussed.

12.6 Details of damages occurring in the different river valleys in various years have also been given.

12.7 Clear cut measures to be adopted, on detailed examination of individual cases, have been suggested. A comprehensive plan has been put up to deal with the floods occurring in the Bombay State.

In conclusion it can be said that the valleys of River Bhima, Krishna, Godavari and Tapti are urgent cases for detailed investigation on the lines suggested above in this paper.

Acknowledgments

The author wishes to express his thanks to Shri G. N. Pandit, I.S.E., Superintending Engineer, P.W.D. for his valuable suggestions. The author's thanks are also due to Dr. D. G. Kulkarni, S.P. and Shri D. B. Dongre, D.E., for their valuable assistance in the collection of data and checking of figures used in this paper.

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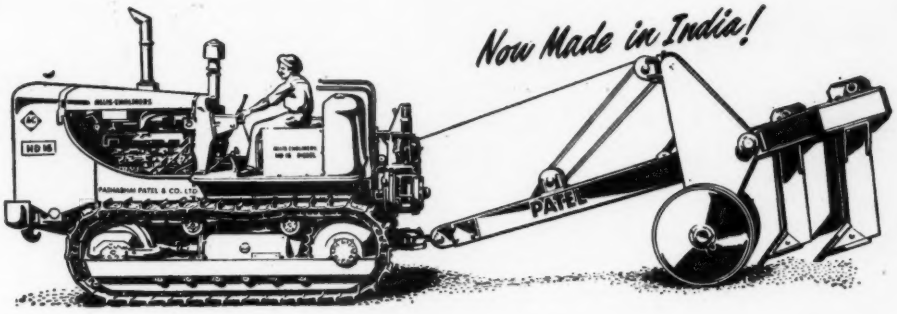

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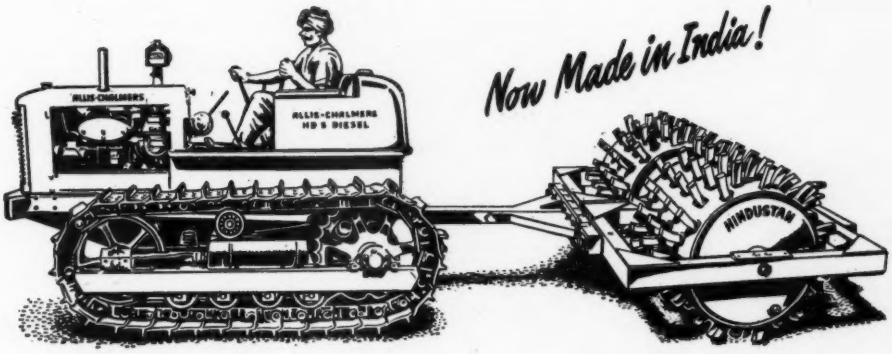

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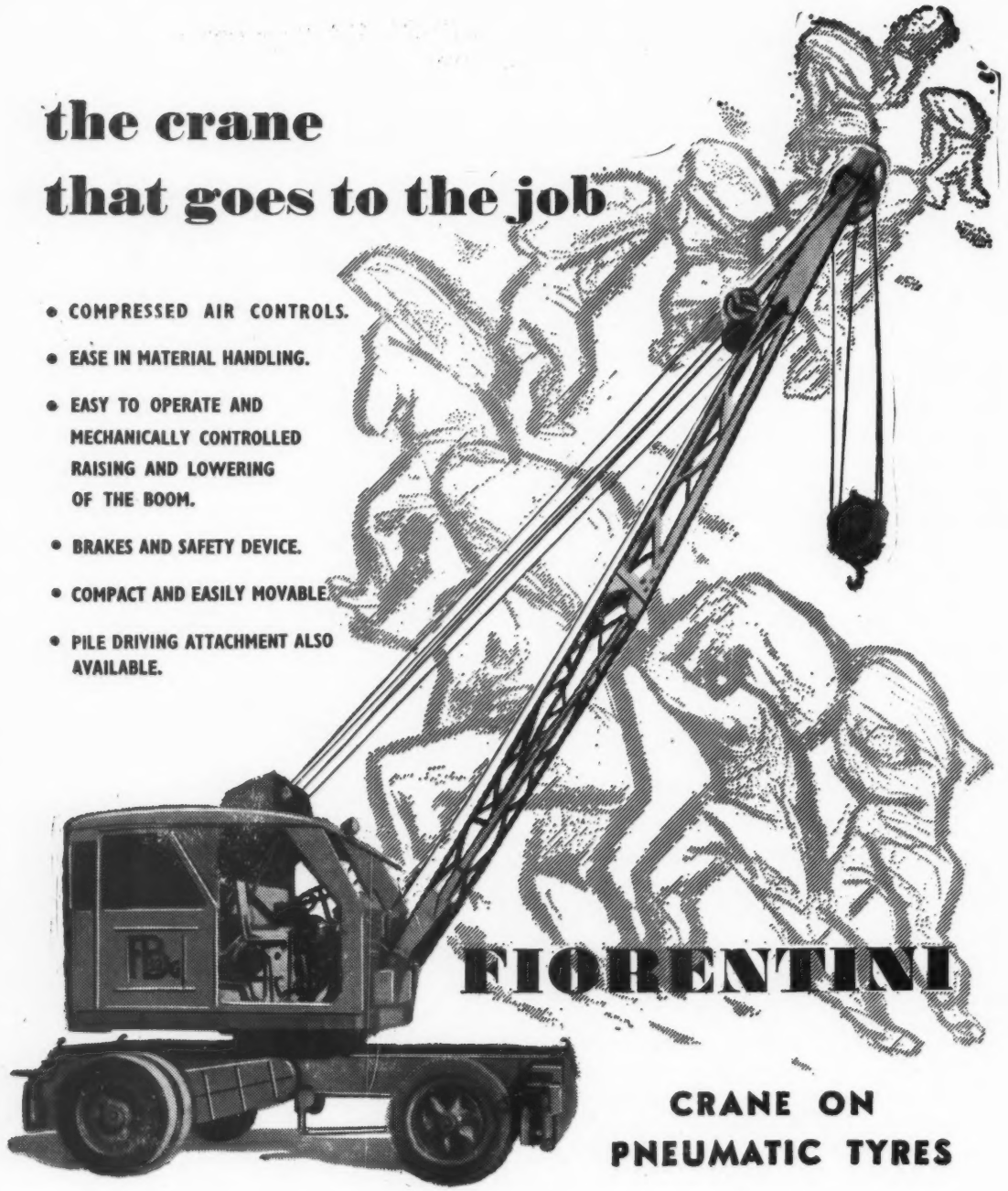

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FSMP-4

Floods and Flood-Control— With special reference to Bombay State

By
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AUTHOR

1.1 A flood can be described as that stage at which the stream channel becomes filled and above which it overflows its banks. All floods are primarily due to surface runoff. Floods may result from (1) An intense rainfall, (2) Melting of accumulated snow or (3) Melting of snow combined with rain as in the case of rivers with Himalayan catchments.

1.2 Floods are indeed both a boon and bane to the part of the country affected ; 'Boon' in that, large quantities of water are made available for Agricultural, Industrial, Power and Navigation purposes ; and, all life, being supported by water, thrives thereby ; while floods prove a bane, when they are heavy and bring damage, devastation, ruin and untold misery in their train to the entire populace, their cattle and their properties. It is the high floods that are before our mind's eye when we think of Flood Control.

1.3 To avoid damage and destruction due to high floods, dams must have sufficient spillway capacity and adequate protection against scour at the toe ; bridges must have adequate waterway (open). Flood Embankments must be high enough, so that they will not be overtopped and the section and construction must be sound and storage reservoirs must have the required capacity. The maximum flood that any such structure can safely pass is called the Design Flood and its choice has to be made and magnitude fixed by careful sifting of available data, and full consideration of the value of the property that would be destroyed as a result of any flood of greater size, and the inconvenience resulting from failure of the structure due to greater floods.

1.4 Flood control has been achieved with great success by providing Retarding Reservoirs ; the outlet capacity is such that the unregulated discharge, with the reservoir full, does not exceed the permissible carrying capacity of the channel through the protected areas. Also, Detention type of Reservoirs are used and they have the advantage of being provided with outlet control which is intended to achieve greater usefulness through flexibility of operation of the reservoir. These are useful when area under control is large in size, and the area to be protected extends for some distance downstream of the reservoir ; then, the advantages of the detention basin type of control outweigh its disadvantages. A well known illustration of the previous type is the Miami Conservancy District system, where, all the five Reservoirs are designed with uncontrolled outlets of sufficient capacity to discharge floods 33% bigger than the 1913 floods, without overtopping spillways.

1.5 Although Bombay State has scarcely any problems of this gigantic magnitude, it has its own problems requiring suitable remedies which may not essentially be the immediate construction of successive reservoirs in the major valleys, the nature of which is outlined below.

2. Main River Valleys in the Bombay State : their particulars

2.1 Details of all the valleys giving an idea of the drainage net, important tributaries, expanse of catchment etc. (details of Konkan valleys have not been given, as it is a group of many sister catchment areas) is given in table appearing in the following page.

2.2 Of these Sabarmati and Mahi flowing from North East to South East and Narbada and Tapti flowing from East to West all join the Arabian Sea, while Godavari and Krishna flowing from West to East join the Bay of Bengal. Tungabahdra and Bhima join Krishna River but outside the State limit. All the streams in the Konkan area originate from Sahyadri hills and flow from East to West and join the Arabian Sea.

2.3 Drainage net of all the valleys is well spread. Almost all catchments are fan-type. The longest one is Narbada and the next longest is Tapti. Then there are Bhima, Krishna, Mahi and Sabarmati, Godavari and Tungabhadra.

3. Necessity of Flood Control

3.1 Bombay State is fortunate in its rich water potential, but ill distribution is an unhappy feature. Major bulk of water runs in an uncontrolled way in the form of floods which cause considerable damage constantly, not only to life and property but also to the agricultural banks and lands by erosion, scouring, cutting up and thus making good lands barren. Floods therefore are required to be properly control-

S. No.	*Valley*	*Total catchment area in State sq. miles*	*No. of tributaries*	*Biggest catchment area of tributaries sq. miles*	*Smallest catchment area of tributaries in sq. miles*	*Length of main river in State in miles*	*Maximum length of tributary in miles*	*Catchment area outside Bombay State in sq. miles and remarks*
1.	Sabarmati	9,360	13	2,806 (Watrak)	128 (Shelva)	250	120 (Meshwa)	Joins the Arabian Sea.
2.	Mahi	12,988	16	962 (Panam)	53 (Veri)	253	76 (Panam)	-do-
3.	Narbada	3,746	15	1,125 (Orsang)	73 (Aswan)	150	80 (Orsang)	4,1700 in Madhya Pradesh etc.
4.	Tapti	13,357	16	3,707 (Girna)	150 (Kan)	295	184 (Girna)	12,945
5.	Godavari	7,186	16	2,540 (Pravara)	70 (Kadwa)	140	120	Further flow in Hyderabad & Andhra States.
6.	Bhima	20,980	15	4,885 (Sina)	134 (Yelwandi)	350	185 (Sina)	Flows further to Hyderabad area and joins Krishna.
7.	Krishna	20,339	20	4,875 (Malaprabha)	73 (Tulshi)	345	188 (Malaprabha)	Flows further in Hyderabad & Andhra State
8.	Tungbhadra.	2,815	5	2,140 (Vardha)	107	100	—	Joins the Krishana River

led, drained and regulated if they cannot be all harnessed. Controlling of floods will allow little damage to occur and will benefit the lands where rainfall is short or unseasonable.

3.2 Floods in rivers left to themselves can do and are doing immense damage to life and property, off and on, specially in country where ground slopes are steep. There are examples of erosion by floods which has laid waste vast areas of otherwise useful lands. But if rain water is controlled and conserved in rivers and reservoirs, it can convert sandy deserts and waste lands into flourishing agricultural lands and garden areas.

4. Nature of Country and Rainfall

4.1 The Bombay State has a diversity of catchment areas of the various valleys and sub-valleys—some have very heavy rains even upto 300″ in a year while others starting from secondary ridges receive only about 15″ to 20″ of rain annually. The slopes vary from 1 in 3 to 1 in 2500 or so. The strata varies from exposed rocks to deepblack soils. Deltaic lands are in very small patches and lie only in the lower sections of the River Valleys.

4.2 Though consequences of floods are very serious, their frequency at a particular locality being low, the question has not assumed gravity so far.

4.3 In olden days for facility of water supply, practically all towns and villages were established on the banks of rivers and streams and damage due to floods was considered as an inevitable danger and faced calmly as a natural calamity. Loss of life and property received was not huge as the population of such localities in olden days was limited.

4.4 Due to increase in population of river side settlements and concentrated agricultural activities on rich river side lands, people began to view with concern the damage by floods. In the past ten years of "Grow More Food Campaign", this received more serious attention of all concerned.

4.5 There were reports of flood damages received from time to time to time in various valleys and at different locations. The local authorities may have also collected the information of such damage but as this was not being collected and compiled practically very little data about past floods is available. It is only from 1946 that information is being collected by the Irriagtion Development Division, Poona (previously this work was done by the then Water Resources and Investigation Division, Poona).

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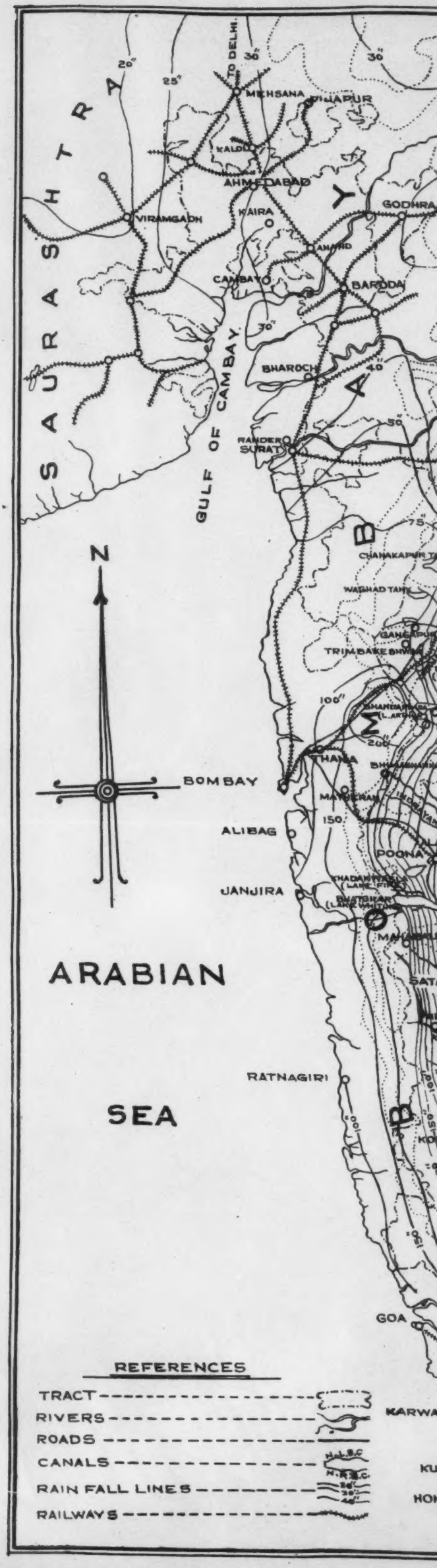

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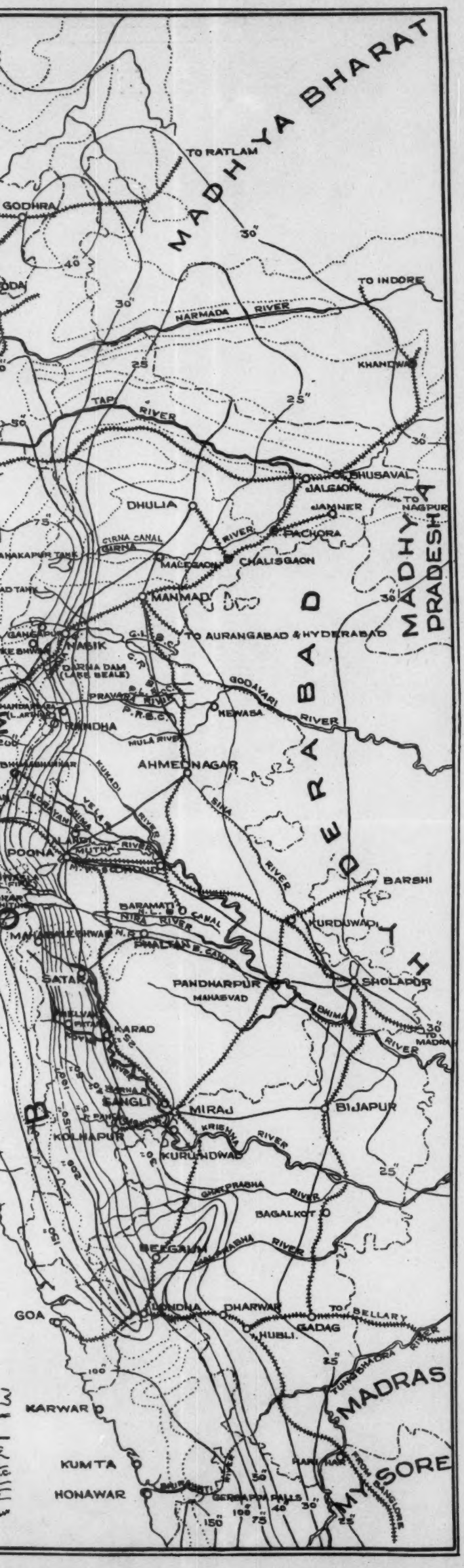
RS & RAIN-FALL



But information about damages by floods at all the places in the Bombay State during the period 1946 to 1953 has not been received.

5. Abstract of valley-wise damages from 1946 to 1955

5.1 Abstract of damages from 1946 to 1955 valley-wise is as under:-

S. No.	*Valley*	*Rough account of cost of damage in year (Rs. in lakhs)*									*Total*
		1946-47	1947-48	1948-49	1949-50	1950-51	1951-52	1952-53	1953-54	1954-55	
1.	Sabarmati	..	Damagex not consi-	..	2.31	..	0.05	..	0.25	..	2.61
2.	Mahi	..	derable as seen from	..	..	..	0.01	..	..	..	0.01
3.	Narbada	..	Nil reports received.		..	0.10	..	..	..	..	0.10
4.	Tapti	..		5.6	..	..	..	..	..	21.00	26.56
5.	Godavari	25.00	..		..	0.10	2.40	0.05	..	..	27.55
6.	Bhima	..	..	0.61	32.96	0.10	..	..	..	1.29	34.96
7.	Krishna	..	..	..	0.11	0.60	..	0.52	28.43	..	29.66
8.	Tungabhadra	..	..	..	..	0.90	..	..	0.08	..	0.98
9.	Konkan	..	..	..	1.76	0.20	0.14	1.43	2.20	..	5.73
	Total Rs. in lakhs	25.00		6.17	37.14	2.00	2.60	2.00	30.96	22.29	128.16

6. Brief account of floods in the different valleys of the Bombay State.

6.1 *Sabarmati Valley*

The river had very big floods in 1893 and high floods in 1909 and 1941. Floods in 1944 were again very high but damage in these floods is reported to be not so high.

In 1949 the tributaries Bhogawa and others were in floods in July and about 10,000 acres were badly damaged. Village roads were cut off and washed away.

In 1951— The tributary Meshwa had floods twice in July and once in August and pitching of Cross-Drainage Works only was damaged.

In 1953 — Sabarmati had floods once in July and twice in August and crops of several acres and one road was damaged to the extent of Rs.25,000. Cost of total damage from 1946 to 1954 is upto 2·61 lakhs of rupees.

In 1955 — On 1st September, Watrak & Sabarmati rose in floods and heavy damages are reported.

6.2 *Mahi Valley*

In 1951 only small tributary had high floods. Flood damage was negligible.

6.3 *Narbada Valley*

In 1898 there were very high floods which eroded considerable river side land. In 1910 the river moved about 2000ft. northwards. It again returned to its old course after 40 years.

The Westen Railway alone suffered a loss of about a lakh of rupees from 1930 to 1935 due to the floods of Narbada rising from 20ft. to 35 ft. gauge height.

In 1950, floods of Narbada and Karanjan Rivers washed away material collected for four roads under construction and damaged a dip.

Damage from 1946 to 1954 was negligible.

6.4 *Tapti Valley*

The River Tapti had high floods several times viz in the years 1727, 1782, 1822, 1837, 1883, 1884, 1898, 1914, 1944 and 1953.

The Western Railway alone estimates at Rs.90,000 the damage done to its engineering structures from 1930 to 1945 with flood level of Tapti rising from 27 ft. to 42 ft. gauge at the Railway Bridge.

In 1948 — The Tributary Arunavati rising in the Satpuda hills was in high floods. Shirpur town was under 7 ft. to 9 ft. depth of water on 20th July 1948 at 4-30 a.m. with some resultant loss of human life and cattle.

Bridge Nos.77,152 and 156 collapsed and road was damaged due to nallas being in very high flood.

Previous high floods of Arunavati were in the years 1930-31 and 1941. In 1954 also, half of Shirpur town is reported to have been under water.

Total cost of damage was estimated at Rs.5.56 lakhs during 1948-49 and Rs.21 lakhs during 1954-55.

6.5 *Godavari Valley*

The catchment of Godavari in its head reach is subject to heavy rainfall. This valley flood causes flood damage very often in the developed areas of Rahuri, Newasa, Belapur and other Talukas. Amongst the tributaries Mula and Pravara are the major ones.

In 1946 floods of Mula and Pravara in the second week of November submerged vast portion of developed areas and affeected 117 villages including Taluka towns, 28 human beings and 707 cattles were drowned, 3324 houses and huts damaged either completely or partially and fruit gardens of Rahuri washed away. 17,000 persons became destitute and Rs.3 lakhs were sanctioned by Government for free ration, hutting materials, etc. This gave rise to the formation of new Co-operative Housing Societies and the new Rahuri township which promises to be a prosperous trading centre by virtue of its proximity to the Rahuri Railway Station.

In 1950, Godavari floods were spread overlow lying area of Kopargaon town on 21st July with the result that banks were scoured considerably. Height of flood was 26.5 ft.

In 1951, floods were mainly due to Godavary and its tributary Pravara whereby lands were washed away, crops and buildings were damaged on 14th and 15th October to the extent of Rs.2 lakhs. In 1952 In 1952 the river Godavari rose to 31 ft. at Kopargaon in the last week of July but considerable damage wsa not caused as floods receded early. The tributaries Pravara and Mula also had floods but the damage was not so heavy.

The total damage from 1946 to 1954 amounts to Rs.27·55 lakhs. It is seen that Godvari and its tributaries Mula and Pravara are responsible for this loss. There is already a storage (Bhandardara) at the head of the sub-valley Pravara and the Gangapur Storage is at the head of the Godavari Valley (recently completed). There are no reservoirs at the the head of the Mula Valley but two are contemplated. In 1946 however, it was experienced that Bhandardara storage on Pravara did not help in controlling the floods being at the head of the Valley. This valley deserves priority for flood control measures as the area affected by floods is developed due to irrigation by canals and is rich in sugarcane, fruit gardens and food and fodder crops.

6.6 *Bhima Valley*

Heavy Rainfall in the Western Ghats bring floods also in the sub-valleys spread over different areas. The tributaries Mina, Kukadi and Ghod all join the Bhima River.

In 1948, the tributary Mina caused heavy floods on 22nd November, with high flood level about 8 ft. higher than previous floods of 1926. Bridge at Narayanagaon had some damage. Other tributaries viz., Kukadi and Ghod and the River Bhima itself were also in floods at that time.

In 1949, the extraordinaty flood of Bhima river in Bijapur District was received. The damage caused, losses suffered and the panic created was so great that Bijapur District people cannot afford to forget the day 19th September when it rained non-stop for about 72 hours recording about 7″ of rains at Bijapur during the period. 5 lives and 600 cattle were lost. 12 villages were seriously damaged. About 1400 houses were badly damaged. Fodder worth Rs.30,000 washed away and 2600 bags of cereals lost. These extraordinary floods seem however to be rally very rare as such floods have, it is reported, not occurred, not occurred during the last 100 years.

In 1950, Nallas on Indapur Nira Road joining tributaries of Bhima were in flood on 25th August and Miles 14 annd 15 of the road were damaged.

Total damage from 1946 to 1954 amounts to Rs. Rs.33·17 lakhs.

6.7 *Krishna Valley*

It will be seen that upstream of Karad there is practically no damage due to floods though they may rise high as the banks are defined and high and the river side lands slope away sharply. The damage begins from Karad downwards. Warna Don and Panchganga are the two tributaries which usually cause considerable flood damage.

In 1949, the tributary Don with high velocity and flat banks submerged big areas and caused damage to causeway on Sholapur-Hubli Road. Similarly the small tributary Agrani caused damage to Sambarji Pandagaon Road and Kurundwad Shirol Road and submerged lands. The Bijapur town itself received very heavy rains in September 1949 when several houses with mud roof had collapsed and several residents were without shelter. Kurundwad town usually gets almost surrounded by flood waters.

In 1950, the tributary Don again rose in floods on 2nd June 1950 and damaged causeway in Bijapur Bagewadi Road, with some loss of life.

In 1953— Several tributaries, viz. Warna, Nandini, Yerala, Panchganga Ghatprabha, Malaprabha were in floods, many of them in July and others in September and October. Kolhapur received 7 inches of rainfall on 30th June 1953. Many houses collapsed and several were damaged. Previously such a high intensity of rains was received in 1919. Crops of paddy, nagli and sugarcane on 13,500 acres were affected, 3,000 acres bing washed away. About 5,200 cattle died by drowning and cold. The damage was estimated to cost Rs. 28.43 lakhs.

The total damage from 1946 to 1954 amounts to Rs.29.66 lakhs.

6.8 *Tangabhadra Valley*

In 1950, the tributaries Vardha River and nallas rose in high floods on 2nd July and again from 1st to 4th August, when two villages were affected, causeway was damaged, a boat got capsized and crops were lost.

In 1953, Tungabhadra rose in floods on 9th July and only some houses were damaged. The total damage from 1946 to 1954 was Rupees one lakh.

6.9 *Valleys in the Konkan*

Practically every year one or the other of the several rivers in the Konkan have high floods and cause cosiderable damage. Sometimes when heavy, widespread storms visit the locality, many rivers rise in floods simultaneously and heavy damage is inflicted.

In 1949, the Jagbudi riverhad abnormal floods. 75% of the area of Khed (Taluka town) was submerged on 13th July 1949 and considerable damage was caused to private property and to two bridges. Loss is roughly Rs. 1½ lakhs.

In 1950 Nallas in miles 111 to 122 of Bombay-Goa and 39 to 44 of Bombay-Poona and miles of Udhva Panvel Road were in floods, (such floods had occurred 60 years back), and road surfaces were washed away and cutup.

In 1951 — Many small rivers and nallas in Kolaba and Thana Districts were in flood in July, damage done being not heavy.

In 1952, the river Ulhas was in floods and earthen

banking of road was washed away and retaining walls damaged.

In 1953, there were heavy rains on 30th June and 1st July and it caused great loss. The River God changed its course (a phenomenon well known in living memory) and submerged lands of width of about 2 furlongs on both banks for a length of ten miles. More than 1,000 cattle died and 17,000 acres got considerably damaged.

Total cost of damage thus works out to Rs.5.73 lakhs from 1946 to 1954.

It might be recalled that between 1931 to 1933, all the rivers in the Ratnagiri District had abnormal floods and the arched bridges designed with waterways calculatd for discharges as per Beale's curve were all overtopped by floods. A case was therefore made out and Government ordered the use of the Strange's curve with an allowance of 10% for designing waterways of Konkan Rivers.

7. Floods, River Behaviour and Flood Control

7.1 River behaviour resolves itself in a series of problems as below—

(1) Meandering.
(2) Scour of Bed and Banks and Soil Erosion.
(3) Spill.
(4) Tidal Action and other obstructions.
(5) Local River Training.

7.1.1 It will be readily conceded that these are manifest and present themselves as problems only when the river is in floods, and, are vividly noticeable as the aftereffects of floods, and, as such, floods can be rightly considered as the primary cause of same ; and, for checking of them flood control measures are necessary.

7.2 Meandering is met with in the case of streams running in the undulating soft grounds and gentle sloping deltaic lands. Streams here seem to have very little tendency to change their courses. Such a change may occur once in several years. In some cases, the change in course may be in the form of swinging up of the curves and regaining its course again during a fixed cycle period.

7.2.1 Instances of changing the course of a stream are few. The river Tapti shifted its course at Surat City and has caused considerable damage thereby. Similarly the River Narbada has been reported to have shifted its course by about 2,000 feet northwards, in 1910, and has again returned to its original position after about 40 years. Tributary of Tapti viz., Arunavati in West Khandesh is also reported to have slightly changed its course near Shripur during the monsoon of 1954 as a result of unusually heavy floods. Similarly in the Bijapur District, the Don Nalla, a tributary of the Krishna Valley, has also changed its course in September 1949 with the result that the villages on the banks viz., Budhihal and others had suffered heavy losses. In 1945 and 1946 there were some indications of disturbances in the course of River Gad and recently in 1953-54 that river in the Ratnagiri District is reported to have changed its course near Kankavali Villages as a result of heavy discharge and blocking up of waterway by the uprooted trees and silt. The phenomenon was never before experienced, in the case of this river or any other river in the tract, for several generations past.

7.3.1 *Scour*—Scouring is another feature which results not only at High Floods but also at the ordinary ones. But scour due to high floods has more damaging effect. Only scour at the Road crossings, Bridge locations, Ghats, Fort walls and other important structures and near Cities, attracts the attention and forms usually the subject of reports of damage, while other scours remain unreported as they go unnoticed for a pretty long time.

7.3.2 Following are example of scouring of the road banks by streams flowing parallel to the road—

(*i*) Bijapur-Bagewadi Road near mile 20 by a nalla on the right side.
(*ii*) Karad Chiplun Road near mile 8 from Chiplun by a nalla on left side.
(*iii*) Poona-Sholapur Road near mile 20 (Right side) by a nalla.

7.3.3 In the above cases groynes have been tried with some success. The nallas to be dealt with are small ones and do not call for any costly measures to be adopted.

Soil Erosion

7.3.4 There seem to be two types. One takes the form of washing away of land and fields, cutting them up into gullies and effecting erosion of the top soil course. This scour is either of the type of sheet erosion or gully erosion. It was noticed in areas in the hills or ground with steep slopes, rains of high intensity and soil of black or brown soil type. Bunding activities in the various districts of this State holds a good promise of checking this type of erosion of precious top soil, which otherwise can wash even upto nineteen tons of soil per acre down into the Sea in a year.

7.3.5 The other type is noticeable in alluvial planes in the north. Slightly different but more malignant and devastating is the lateral massive scour that is caused by the rivers in alluvium. The river erodes actively both while its floods are rising or falling. The heavy erosion of its banks by the Indus in the sandy alluvium planes in Sind, on the other bank where river forms a horse-shoe bend or loop, is a common phenomenon that has always taxed the Engineers and calls for all alertness, skill and ingenuity. During 1934, or so, in the pre-partition days while Sind was part of the Bombay State, heavy erosion by the Indus on its left bank was going on, a few miles upstream of Rohri, where the main river course, had, by shifting towards East formed a sharp loop : groynes were out of question. A cut forming a chord of the loop-curve and passing through the 'LOLAI' Dhand (Shallow island like portion) in the river bed, was proposed and carried out and it proved effective in bridling the devastating Indus River, by redirecting its main current towards West into the Rohri gorge and removing the likelihood of further easterly erosion, thus saving lot of devastation and washing away of the N. W. Railway Line near Mandodairo above Rohri.

7.3.6 Dibrugarh in Assam is another major instance of what horror and devastation the Brahmaputra,

a large river, when in floods, can bring, while actively eroding its bank in the alluvium planes of Assam.

7.4.1 *Spill*—When rivers, specially in the lower reaches, which are comparatively flat, receive high discharges, the flood level is raised above the bank and the flood water flows over, in thin sheet of considerable extent over the fields or land along the River bank. In some cases, the streams short-circuit their course after having cut a by-pass, or through the low portion adjoining the banks.

7.4.2 Damage due to spills is however not very frequent and usually is of a local nature. A typical instance may be cited of the waters of Tapti River spilling away over considerable widths of side lands near Surat and damanging portion of the Bombay Ahmedabad Road near Rander as happened in 1944.

Tides

7.5.1 Tidal action is only experienced along the West Coast by the rivers flowing into the Arabian Sea from the hilly Konkan Region and from the Gujarath Plains. Maharashtra and Karnatak have no tidal trouble, there being no sea.

7.5.2 Regimes of rivers flowing into the sea undergo changes off and on. It is experienced specially in the Konkan that flood damage is aggravated whenever flood combines with high tides.

7.5.3 *Sand Bars*—Many of the creeks of the Ratnagiri and Kolaba Districts have sand bars formed at their outlets into the sea. These, at low tides, reduce the draft required for the ships and boats, and thus become impediment to marine traffic. Sometimes heavy cargo ships get stuck up and cause trouble.

7.5.4 *Silt Load*—The Sahyadri hills are full of rocky and murumy stuff and rainfall is very heavy ranging from 100″ to 300″ per annum. Valleys slopes are very steep and thus the velocity of hill-sterams is considerable, which charges the Konkan streams at high floods with quantities of silt load. At high tides however, the velocity of floods of streams being reduced, the river water leaves its load at or near the mouth width the result that water spills over low portions, bifurcations of current take place, and islands are produced or sand bars formed.

Other Obstructions

7.6.1 *Bridges*—Bridges provide contracted water way to the streams and this causes considerable tortuousness, afflux and sometimes sumergence of houses and lands and at times outflanking and damage results.

7.6.2 (*ii*) *Causeways*—Causeways are another type of obstruction which bring about distortion and spoil the regime of the river whenever heavy floods are received. Considerable afflux results, and water spills over the banks and sweeps over the land which was safe (before the construction of the causeway). By repetition of such overflow of flood water the regime of the stream changes at times resulting into byepasses and cuts or even changes the course of the stream. Near such a site the change becomes so acute that the site becomes totally unsuitable either for a full or submersible bridge. Such causeway if built near a city, for economy, proves to be ultimately uneconomical. To provide a full bridge in the first instance would be judicious. Instances of this type were noticed in the Ahmednagar District.

Local River Training

7.7.1 Sometimes local authorities take steps to train the streams, at places with a view to effect improvement in sanitation or afford conveniences and amenities to the public. Care has however to be taken to see that such steps do not produce material obstruction and bring about any reduction in the normal waterway of the stream ; lest, the peril due to floods is enhanced.

7.7.2 *Cross Drainage Works and Blocking up by land slips* :—Rainfall in Western part of this State is heavy and practically every year there is blocking up of traffic because of the closure of the road by (*a*) land slide, (*b*) land slip (*c*) collapsing of a cross drainage work (*d*) failure of a retaining or revetment wall (*e*) washing away of embankments and other similar accidents caused by hill torrensand floods.

7.7.3 Some roads like Karad Chiplun (1952-53) Ratnagiri Kolhapur (1952) Belgaum Savantwadi or the like are closed to traffic every monsoon and considerable inconvenience is caused to traffic. A single example of "washing away" of Phophali Bridge near Chiplun will give an idea of the damage caused. This small inconvenience or crossing the stream of only about 100 feet involved changing of vehicles and carrying goods and luggage by head load through stream, cost of which has been estimated to about 3 lakhs of rupees for a monsoon season.

7.7.4 In the Districts of North Kanara and Ratnagiri of the Konkan Region, the annual rainfall is over 100 inches. There rice is grown in fields, which are well terraced and rain water even up to 12 inches is impounded. In fact thousands of acres of these lands form shallow basins or tanks and help to effect flood control. This work as an eminent remedy towards the solution of the Flood Control Problem in certain cases.

8. Flood Damage

8.1 The Bombay State is not as unhappy with flood as Assam, West Bengal, Bihar and Orissa States, where the floods are very destructive. But high flood damages do occur off and on, and these have to be avoided and reduced as far as possible.

8.2 Damage by River floods can occur in the different ways (*i*) By intense local rains causing the River floods to overtop or breach their banks (*ii*) By intense rains at various places and/or heavy snowfall in the case of Himalayan Rivers, in the upper reaches of the catchment and outflanking or erosion of banks, far away from the actual locality or rainfall.

8.3 The damage of the former type is rather difficult to avoid. So far no solution has become available to drive away heavy rain storms which may be possible only if and when the art of artificial rain making is mastered by man—and hence intense rains cannot be avoided. But, such very heavy local intensities are not too frequent and the damage done is neither wide spread nor of great magnitude.

8.4 Where portions of cities, towns or mofussil estates are submerged under floods, losses of life, houses, property, crops, washing away of plots, commodities etc are usually calculated. But it is also necessary to include in damage the following items :

84.1 (*i*) Extra expenditure incurred by villagers in shifting their bag and baggage and re-establishing same.

8.4.2 (*ii*) If as a result of floods, some epidemic starts, cost of medical aid and allied charges has to be valued on the same lines as is done in the case of calculating damage due to malaria.

8.4.3 (*iii*) If certain concerns like workshops, etc have to stop working for some days, losses involved, though not paid for by the State, have to be calculated under flood damage.

8.4.4 (*iv*) Losses due to breakdown of Roads and Railway communications including loss sustained by passengers and the management and authorities, cost of all relief and high cost of all transport.

8.4.5 (*v*) The approach channels and sump wells etc of the lift irrigation schemes within the flood affected area get blocked up due to floods and go out of working with the result that valuable crops of sugarcane, fruit trees etc get damaged for want of timely waterings. Flood damage should include cost of such damage also.

9. Measures for effecting Flood Control

9.1 *Cross Bunds*—Big bunds put across small river valleys are effective as flood control measure. A series of bunds or dams of the Minor tanks in several small sub-valleys of the North Kanara District which form such bunds afford the following benefits besides irrigation, for which they were constructed.

(1) Bunds arrest sand coming down the stream and spoiling the fields and prevent the washing off of soil and preserve it in site.
(2) Broken ground near foot of the hill is levelled up and can be reclaimed with ease for cultivation.
(3) Spring level of wells on downstream is raised.
(4) Where the wells have brackish water same gets diluted and improved.
(5) Lands downstream receive percolation and are consequently benefitted.

9.2 *Bandharas*—Many bandharas are being constructed for helping irrigation. These divert flood water to some extent away from the stream and effect some flood control. A series of bandharas in a valley would be useful "Flood Control" measure, in addition to their function of irrigating lands.

9.3 As damage due to floods is the result of very high discharges coming down from upper reaches of the catchment and spreading over the low lying lands of lower regions following remedies are suggested.

(1) Reduction of peak discharges by storages and/or basins in the upper reaches.
(2) Lowering flood levels by improving discharging capacity of the river section by various methods.
(3) Diverting part of the River discharge through by-passes for protecting the low lying areas.

9.4 Increase in floods with afforestation is recognised. Consequent denudation and soil erosion need to be dealt with by—

(1) Better field cultivation.
(2) Aforestation of village waste lands and hills, and
(3) Conserving grassy lands.

9.5 *Storages*—Storages at times help to control floods though not designed specifically for this purpose. Large reservoirs cannot diminish the size of floods but they can hold all heavy floods from going down into the valley below until they get filled to their full supply level, and effect a time-lag by which time the flood may get reduced in intensity. Here reservoirs get filled up by the end of July every year and if and when peak discharges arrive, after that, due to heavy storms, these storages cannot at all serve for flood control.

9.5.1 Recently on 15th July 1954, the Mutha Valley of the Deccan Region recorded highest runoff of 1,05,674 cusecs for a catchment area of 196 square miles when the Khadakwasla lake being practically full could not effect any flood control inasmuch as the portion of Poona City about 8 miles downstream was submerged and suffered damage. The replenishment received from Catchment Area from 11th to 16th July 1954 was so enormous that even though all the automatic gates (Discharging capacity 74,880 cusecs) were open throughout the period, the water level in this big lake (area at F.S.L. 6 squtare miles approximately) rose 2.50 feet above the designed level and thus endangered the dam. (Luckily no more replenishment was received and the situation was relieved in next 24 hours).

9.5.2 It is thus not correct to expect such a big reservoir to function as a measure to effect Flood Control at all times. It is not always practicable to utilise water supply storages or Irrigation Reservoirs both for the purpose of storing water for domestic or irrigation use and also for Flood Control. In only rare cases it may be feasible to adopt a procedure of partially filling up reservoirs, leaving adequate margin and capacity in reserve for absorbing likely floods, and then regulating opening of outlets during floods and closing same by the end of the flood season and allow the storage to be filled up with the final inflow. For this being possible levels allowing a margin sufficient to absorb the expected floods have to be worked out and an accurate estimate of floods and their expected time must be known. But this is not always possible even with the available forecasting of storms issued by the Meteorological Obersvatories.

9.5.3 The method of using irrigation storage reservoirs for Flood Control involves another danger viz., that if the peak discharges are not received or if the replenishment after the peak discharges is not obtained, the reservoir may remain empty and the irrigation dependent on it would suffer horribly.

9.5.4 It will thus be seen that the Irrigation or Water Supply or Power Reservoirs, the storages can play but a minor role in respect of flood control ; unless they have been designed for flood control, in

addition ; that is feasible in the case of multi-purpose Reservoirs.

10. Planning Flood Control

10.1 Damages from floods may be avoided in three different ways or their combination as warranted by the locality and situation.

(1) By the construction of protective works such as Levees or the gigantic Bund system in Sind, bunds being protective earth banks along river bank with sluice openings and Service Road with sufficient freeboard over known highest levels of river in flood. These are also feasible in the Indo-gigantic plains in Northern India in some cases, and are being adopted along with the proposed Barrage to achieve the Flood-Control of the Kosi, in Bihar.
(2) Through the reduction of flood-stage without appreciable change in the peak discharge.
(3) Through the reduction of flood flows by storage change in land use or similar methods of land conservation.

10.2 Can storage reservoirs be built up for effecting Flood Control? Purely from the structural and irrigation engineer's point of view the answer is in the affirmative provided sites suitable in all respects for the Dam and Waste Weir are available, use is found for the stored water, and a fair return on the capital is guaranteed. But this will not be the acceptable solution if it does not stand proper scrutiny of economic considerations of the damage saved by flood control, as the size and cost of the storages for full flood control are bound to be tremendous. It is for this reason that the Orissa Flood Advisory Committee came to the conclusion, that reservoirs are not financially practical, if constructed solely for flood control. As compared to Orissa, Bombay experiences flood damages which are comparatively less in extent and magnitude. The necessary of providing reservoirs for flood control only, does not, therefore, seem to be warranted.

10.3 Flood control measures can, and should form, part of the Multipurpose project proposed to be undertaken for harnessing large rivers and fully utilising the regional water potential.

10.4 In any individual sub-valley with steep slopes and heavy rainfall, retarding basins can be designed and constructed economically so as to reduce the flood damage by allowing only the portion of peak floods equal to the carrying capacity of the stream, and leaving the remaining quantity of flood water to flow later with a time-lag. Retarding basins differ from reservoirs or storages in that, they come into use only at infrequent intervals, and, then, only for short periods of a few days or only some hours at a time. The retarding basins function not as storages, but, just regard or delay the flow of water downstream.

10.5 If in the future some of the sub-valleys of the Sahyadri hills happen to be full of fruit gardens producing valuable yields, occasion may arise for designing such retarding basins as flood control measures, their cost being economical in comparison with the loss that may be sustained by garden lands, as a result of flood damage.

11. Suggestions

11.1 Neither economy can be ensured nor security assured by planning protection against floods at exhorbitant costs by adopting a flood magnitude by mere conjectures or impressions. It is, therefore, imperative that magnitude intensity duration and frequency of known big floods in the past be studied and then only decision be taken about the maximum to be actually provided. It is, therefore, very essential to have a systematic study of old data and arrange for collection and preparation of current data of the following nature :—

(1) Correct data for precipitation and particularly of long period rainfall and heavy storms on valleys under study and their adjoining catchments.
(2) Frequency curves.
(3) Frequency of Intense rainfall at a point.
(4) Preparation of Isohyetal maps.
(5) Discharge observations of streams.
(6) Computing correctly the discharges of drainage basins every years.
(7) Computation of discharge for a series of years and keeping correct record with critical commentaries prepared every month and at the end of each flood season.
(8) Calculation of the absolute maximum discharge which may occur once in 50 or 100 or even more years, (*a*) by statistical or probability methods, (*b*) by means of empirical formulas, (*c*) by use of the unit hydrograph principles, systematised by Sherman.
(9) Fixing up design floods for each river or stream for purposes of storage reservoirs and also for flood control works with details and assessment of cost of flood damage that can be saved thereby, and an idea of security afforded to new enterprises of agricultural and industrial type.

11.2 Knowledge of discharge passed by each stream throughout the year is most important.

11.3 For obtaining discharge velocity rods, or, better still, current meters are used and velocity is found while discharges can be computed with the previous knowledge of cross sectional areas of the compartments of the Cross-Sections at the gauge site.

11.4 But as current under measurements are very costly and time-consuming for being repeated at daily intervals, 'Rating Curves' with stage discharge relation established, are very useful. To obtain a satisfactory record of stream flow it is necessary to have (1) a permanent gauge installation, (2) a number of discharge measurements covering a considerable range of stages and (3) knowledge of the relationship between stage and discharge.

11.5 Next we must know the flood producing capacity of the drainage basins. We have to find out what maximum flood can be expected in a particular drainage basin or a river valley and what its frequency will be. Then we have to examine what dangers and losses are likely to occur due to maximum floods and determine a suitable magnitude of flood for design of works, duly considering the nature and amount of loss by flood damage which will be prevented by the structure based on the design flood to be adopted.

(*Continued on page* 10)

Electric Power Conference of ECAFE Countries

Asian electric problems, including nuclear energy prospects, were discussed by some fifty delegates from fifteen countries and territories at a six-day conference of the United Nations Economic Commission for Asia and the Far East which began in Bangalore on March 7.

Opening the fifth session of ECAFE's Electric Power Sub-Committee Dr. P. S. Lokanathan, ECAFE's Executive Secretary, said that the electric power situation in Asia has continued to improve at an increasing level in the last few years. However, the region with more than half of the world's population produced only a little more than 6% of the world's electricity supply. Moreover, Asian power expansion though significant, lagged behind more industrially-developed countries. Many Asian countries were still suffering from acute electric power shortage and the electricity supply in most countries was inadequately to cope with the rapid rise in demand from industry and agriculture.

ECAFE's activities in field electric power had an impact on electric power progress in Asia and the Far East, especially in the coordination of thermal and hydro-electric power, rural electrification, forecasting of power demands, and application of electric power to metallurgical and chemical industries. Recent ECAFE meetings, he said, had shown the keen interest of Asian governments in the possibilities of atomic power. ECAFE's activities in this field would be coordinated with the proposed United Nations Atomic Energy Agency.

Experts from Australia, Ceylon, China, France, India, Indonesia, Japan, Malaya, Nepal, Pakistan, the Phillipines, U.K., U.S.S.R. Viet Nam attended the Conference. Also present were observers from ILO, the International Organisation of Employers and the International Chamber of Commerce. Two West German experts attended as distinguished guests. Several study tours to electric power installations and factories in India were arranged for delegates during and after the conference.

Atomic Prospects for Asia to be Studied by Committee

Asian and other under developed countries have an important part to play in the advancement of atomic power by preparing their economies for the day when atomic power stations can be built economically enough to enable them to obtain cheap power.

This is outlined in a report on the "Use of Atomic Power for Generating Electricity" by the U.N. Secretariat to be discussed by a sub-committee meeting. The report includes a summary of papers presented at the International Conference on the Peaceful Uess of Atomic Energy held in Geneva in August 1955. The group which will study it is the Sub-Committee on Electric Power of the Committee on Industry and Trade of the Economic Commission for Asia and the Far East.

Lines of Action

Pointing out that the enormous costs of research and development in the atomic field—for reactor development alone, the United States Atomic Energy Commission has estimated $199 million to build five reactors over a period of five years—limit such experimentation to the more industrialised countries, the report suggests that underdeveloped countries should take the following lines of action.

As it may be ten to fifteen years before atomic power stations in comparatively small sizes—5,000-20,000 kW—are available that can complete economically with the costs of generation in efficient hydro-stations or steam plants, the present growing power needs of various Asian countries will need to be met by expansion of the present services.

These countries should however continue to study current developments in the use of nuclear fission and in the meantime prospect their own resources for radioactive minerals. This would necessitate the training of manpower in such fields as identifying radioactive minerals, processing mineral ores into forms adapted for use in nuclear reactors, the operation and research with nuclear reactors, and the use of isotopes in industry, agriculture, and radiological treatment of diseases.

Technicians Wanted

Assistance of industrially advanced countries such as the United Kingdom or the United States would be valuable in this respect as they have already realised that atomic research and its application will require large numbers of technicians and are taking steps to attract more teachers into the profession of instructors on scientific subjects and more students into the various branches of physics, chemistry, metallurgy and engineering.

International arrangements for exchange of information on atomic techniques are already being discussed in the United Nations. Countries installing atomic reactors will be able to share their experiences with others and afford training facilities to technicians from other countries. Several Asian countries, including India and Japan, are reported to have plans for the installation of nuclear reactors with the accompanying training programmes.

Study of Present Resources

As wider utilisation of mechanical power is the keynote of modern industrial development, the countries should consider the extent to which their means of production can be economically mechanised. Forecasts should be made of the energy requirements in terms of both commercial and non-commercial sources with reference to agricultural and industrial programmes.

The hydro electric potential of rivers, the fuel resources and the costs of generating electric power should be studied and adequate programmes for installing generating capacity with present resources should be drawn up.

In these ways countries can prepare for the utilisation of atomic power when it becomes available.

The sub-committee during its six-day session also considered among others, the standards for electrical plant and equipment and standardisation of system practices, rural electrificacion, and techniques to be studied during the proposed study tour of Asian electric power experts to European countries.

In a note on the last subject, the secretariat says the value of the visit, likely to come off during this year, will be particularly important as it will enable the Asian experts to modify or alter their plans suitably in the light of the experience gained in the more advanced countries of Europe.

Discussing the specific aspects to be studied during the tour in order of their importance to Asian countries, the secretariat is of the opinion that they should cover besides others, the fields of thermal power stations, using low grade fuel, underground hydro-electric power stations, protective system techniques and high voltage transmission lines.

Conference Concludes

Electricity from atomic power has been produced in a small experiment plant in the Soviet Union for almost two years and nuclear electric power stations on an ambitions scale are being or designed are under construction in Britain, the Soviet Union and the United States.

However, it is expected that another ten to fifteen years will be required before production of nuclear electricity becomes economical and can compete in the Asian region with conventional electricity generated from hydro-power or steam.

Atomic energy eventually promises to be of great importance to Asian countries in the development of their economies but even when it comes into use it will not render obsolete or redundant present production methods.

In any case, present and future Asian electric power requirements are so large, and so much in excess of actual and potential supply, that there will be sufficient room for all forms of electric power generation for a long time to come.

These were some of the observations made and unanimously agreed on by some fifty electric power experts from sixteen countries.

Delegates from countries engaged in atomic research offered Asian countries their assistance in research experiments and training. China (Taiwan), India Pakistan and the Philippines reported that they were either installing nuclear reactors or negotiating about their construction. Japan particularly was anxious to go ahead with the installation of reactors and the operation of atomic power plants urgently required within ten years. Concern was expressed about the availability of nuclear fuels and a U.S. offer to make twenty thousand kilos of nuclear fuel available, as well as additional quantities if required, was noted with interest.

Other questions considered by delegates concerned rural electrification, especially outlines for the establishment of rural demonstration centres and designs of small hydro-electric plants. To facilitate assessment of the hydro-electric potential of countries in the region, ECAFE is to convene a working party. Considerable experiences acquired by France in this field were noted and ECAFE is also to cooperate with ECE in this study. In dealing with questions of standardization, experts recommended as a starting point the standardiztion of power system voltages and frequencies.

A study group of electric power experts from the ECAFE region will be visiting Europe and the U.S.A. this year under U.N. auspices. The Sub-Committee considered in detail various questions to be studied by the group and recommended that the tour should to confined to the following countries: Czechoslovakia. France, West Germany, Sweden, Switzerland, the U.K., U.S.S.R. and U.S.A. The nine-week trip is being financed by the U.N. Technical Assistance Administration with the cooperation of host Governments.

(*Continued from page* 25)

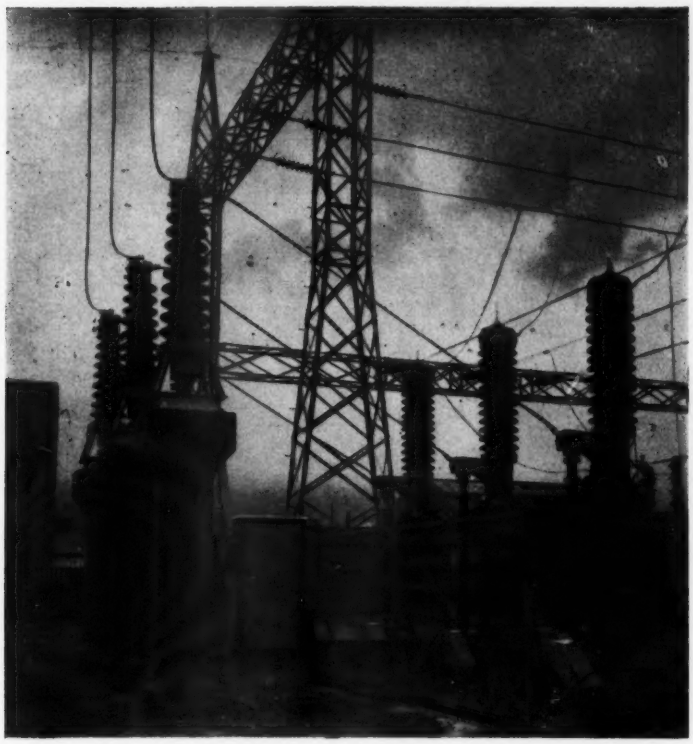
Spherical Roller Bearings in Railway Axleboxes

Over the years the demands made on the performance of roller, bearing axleboxes have become more and more severe. Axle loads, train speeds and annual mileages have increased, and at the same time the tendency in modern bogie and vehicle design has been to restrict still further the available space for the roller bearings. This has confronted roller bearing manufacturers with the problem of developing bearings with even greater carrying capacity in relation to their size. SKF successfully solved this problem by a radical redesign of the spherical roller bearing to give no less than a 40% increase in its carrying capacity. This development marked a major advance in the field of railway bearings and made possible the successful application of axleboxes with smaller external dimensions than hitherto for given loads.

Example of axleboxes incorporating the redesigned spherical roller bearing are illustrated in Figs. 7 and 8. Fig. 7 shows an SKF goods wagon axlebox for four-wheel wagons with an axle load of 20 tons, conforming to U.I.C. standard dimensions. Fig. 8 shows an SKF axlebox for passenger coaches, electric locomotives and diesel locomotives with axle loads up to 24 tons, conforming to A.A.R. standards.

An axlebox for American goods wagon bogies, Fig. 9 is undergoing extensive tests in the U.S.A. Free axial oscillation of the axle in relation to the bogie frame, made possible by the self-aligning feature of the bearing, makes the axlebox particularly suitable for high train speeds. Moreover, this bearing scheme is probably the most economical ever produced for goods wagons.

The development during recent decades has also resulted in the manufacture of satisfactory axleboxes fitted with cylindrical or taper roller bearings of suitable design, each possessing characteristic features. Spherical roller bearings, however, occupy a central position in modern railway bearing engineering as general-purpose bearings. The millionth SKF axlebox was fitted with spherical roller bearings.



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Rural Electrification Demonstration Centres

Several countries in the ECAFE region are actively considering the use of electric power for increasing productivity in rural areas both in the agricultural and industrial sectors. To aid this objective the rural electrification demonstration centres are helpful as they demonstrate the use of mechanised equipment of the types and sizes which can be conveniently adapted for the requirements of agricultural processing and of rural industries. The objective is to enable the rural worker to increase his production by the use of mechanised equipment and thus to increase his earnings. In selecting equipment care has to be taken to ensure that it is of an appropriate size and that the overall cost of operation including annual charges would result in reducing the cost of production. In the adoption of new machines and processes a certain amount of time is needed to convince rural workers of their benefits. It is felt that one or more demonstration centres in each country would assist in expediting this process. The operations of farmers and rural artisans are sometimes on too small a scale to enable economical use of machines. In such cases the adoption of "community facilities" on a co-operative basis enables rural population to derive the benefit of mechanised processes.

Rural electrification demonstration centres are also useful for making productivity trials on mechanised equipment which has not been commonly in use in the country and in demonstrating its benefit. In most of the cases considered electricity is employed for furnishing mechanical power and in areas where a shortage of electric power is hampering the use of mechanised equipment, the use of diesel engines of a suitable size for providing the power requirements of a demonstration centre, would enable the country to popularise such equipment and thus expedite the process of increasing the productivity of the area. When electric power is available the diesel engine can be shifted to other areas and replaced by electric motors thus helping to build up quickly remunerative loads in rural areas.

Four countries—Ceylon, Pakistan, Philippines and Thailand—have expressed an interest in the implementation of such projects.

Ceylon and Thailand had requested the advisory services of the ECAFE Secretariat in the preparation of their plans. As a result of a study of the specific situations in which demonstration centres are proposed to be constructed by these two countries and their requirements, recommendations were made by the Secretariat regarding equipments suitable for them. The Government of Thailand, in the light of these recommendations, are preparing estimates of costs for the buildings, extension of the power line to the centre and for internal wiring for the equipment. The Government of Ceylon are considering the recommendations and are obtaining further information regarding specific equipment for use in mechanising pottery and coir industry.

This paper describes the broad outlines of typical demonstration centres and includes a list of the equipments considered suitable for installation.

Demonstration centres may be of two kinds. They may be built up for individual industries such as the following :

(*a*) Pottery
(*b*) Power looms
(*c*) Cutlery
(*d*) Carpentry and furniture making
(*e*) Coir processing and coir ropes
(*f*) Brick making
(*g*) Silver and brass work.

The equipments proposed for the centres for pottery, cutlery and carpentry shop are indicated in item A of Appendix 1. These centres could be located at different places where there are concentrations of artisans operating the respective industries. As soon as one experimental centre of each type operates successfully, consideration can be given to ways and means of establishing more centres on operational basis.

Alternatively a common centre can be established for all types of agricultural processing and industries. The sizes of equipments to be installed would depend on the needs of each location. The equipment listed in item B in Appendix 1, is for an area which produces rice, maize, sorghum, ground-nuts soybean, green beans, castor bean, sesame, cotton, banana, custard-apples, coconuts and vegetables. It is estimated to cost approximately $51,600 in foreign currency and $5,800 in local currency, and is intended for the following purposes.

(*a*) Saw mills for processing lumber for house building
(*b*) Carpentry shop for making furniture
(*c*) Grinding maize for fodder
(*d*) Rice mill
(*e*) Oil mill
(*f*) Cotton ginning
(*g*) Small workshop for the colony
(*h*) Cold storage and ice plant
(*i*) Electric pump.

The Sub-committee may like to review the experience of countries of the region regarding recent developments in respect of uses to which electric power has been put in rural areas particularly in village pottery and manufacture of coir products, and the methods which have been employed or propose to employ in promoting greater use of electricity in rural areas.

The Sub-committee may also like countries to suggest the specific lines on which further studies by the Secretariat would help their individual programmes of rural development.

Appendix I

Item A : Equipment for rural demonstration centres for individual industries

Prices under this item are f.o.r. port of entry.

Pottery

1. One clay mixing machine adequate for 12 potters

2. Six potters' tunrtables More turntables may be installed later.
4. One kiln to be built adequate for the products of all the members of this centre.
4. Six wheelbarrows for conveying clay and finished products. (When other processes are mechanised, it is appropriate that simple mechanised appliances should be used for handling the materials and products).

Agricultural implements

1. Pneumatic forging hammer 3 cwt together with an electrically driven air compressor with an air pressure vessel and with pressure controlled starting and stopping switch for the motor.
2. Power hack saw.
3. Two snagging grinders 16″ double ended type complete with electric motor.
4. Two buffing machines 12″ double ended type complete with electric motor.
5. One electrically driven blower for the forge

Total power requirement 65 hp
Total estimated cost of above machines $8,750

Brick making

1—Brick making machine capacity 600/800 bricks per hour complete with electric motor $7,580

Wood working shop

1—Jointer 8″ (203 mm) with 3/4 hp motor.
1—Thicknessing planer planing width 310 mm, planing height 1—245 mm, length of table 60 cm with 3 hp motor.
1—Radial saw. Depth of cut 10.75 cm, 40.8 cm saw blade with 3 hp motor.
1—Wood cut off saw combination type with 5 hp motor.
1—Jig saw, throat capacity 61 cm with 1/3 hp motor.
1—Band saw 76.2 cm with 3 hp motor.
2—12″ (305 mm) wood turning lathes.
1—Mortiser ½″ (12.7 mm) with ½″ hp motor.
1—Portable router with 1 hp motor.
1—Portable sander with 1 hp motor.
1—Hand operated dowel and rod turning machine.
1—Disc sander 16/18″ (406/457 mm) disc 3/4 hp motor.
1—Pedestal grinder with 1 hp motor.
1—Drill press 20′ (508 mm) with 1 hp motor.
Total estimated cost $7,000

Item B : Equipment under consideration for a typical demonstration centre for processing of agricultural products and for rural industries

Prices under this item are c.i.f. port of entry.

Saw milling machines

1—Horizontal band saw with 25 hp electric motor. It will take a log up to 1.5 m diameter and saw from 2 to 4 cu m of timber per hour according to hardness of timber and site conditions. Speed of feed is up to 60 m per minute.
Estimated cost $4,625

1—Band re-saw for sawing square logs into smaller thickness as well as for centre cutting the planks and battens sawn by saw frames. Speed can be adjusted from 7 to 50 m pre minute. One 25 hp motor with variable speed adjustment.

Estimated cost $4,290

1—Gang rip saw—automatic combined single and straight line gang rip saw with the following particulars : maximum diameter of saw blade when used as single rip saw 460 mm ; when used as gang rip saw 300 mm. Minimum diameter of saw blade 180 mm ; height of cut when single ripping 150 mm. One 30 hp motor with variable speed adjustment will be included.

Estimated cost $5,190

Carpentry shop

1—Thicknesser—300 mm width, planing height from 1 to 245 mm, with 3 hp motor.
Estimated cost $700

1—Band saw—wheel diameter 700 mm, height of cut 400 cm, with 4 hp motor.

Estimated cost $527

1—Chisel or chain mortising machine, using chain or chisel. Maximum capacity when using chisel up to 25 mm, capacity when using chain $30 \times 75 \times 150$ mm, using 4 hp motor.

Estimated cost $840

1—Scrapping machine—maximum width 600 mm, maximum thickness of wood 150 mm, using 5 hp motor.

Estimated cost $1,645

1—Spindle moulder to take timber up to 150 mm thickness into any desired shape. 4 hp motor.

Estimated cost $896

1—Hand jointer—planning width about 250 mm, with 1 hp motor.

Estimated cost $285

1—Hand sander—sanding plate 200×40 mm, oscillation about 6,000 sanding strokes per minute, requiring 1/4 hp motor.

Estimated cost $42

1—Grinding wheels, for planning knife and for other kinds of tools, requiring approximately 1 hp.

Estimated cost $184

Total estimated cost for carpentry shop $5,119

Corn shelling and grinding machines

1—Corn shelling machine, capable of 25 "tang" (20 litres) of corn per hour, using an 8 hp motor.

Estimated cost $800

1—Hammer mill for grinding shelled corn, using 5 hp motor.

Estimated cost	$305
Total estimated cost	$1,105

Rice milling machine

1—Complete rice milling machine capacity about 3 tons per 8-hour day comprising rice huller, rice polisher, paddy separators, rice separator, bran extraction fan, husk discharging fan, bran collector, lot of shafting, pulleys, beltings and accessories, requiring 10 hp motor.

Estimated cost	$3,815

Oil mill machinery

1—Oil expeller—capacity 1 ton per 8-hour day with 5 hp motor.

Estimated cost	$1,095

1—Crusher with 2 hp motor.

Estimated cost	$350

1—Oil filter press with ½ hp motor.

Estimated cost	$225

1—Ground-nut sheller—capacity 150-300 kg per hour using 1½ hp motor.

Estimated cost	$380
Total estimated cost	$2,050

Cotton ginning machine

1—Cotton ginning machine—capacity about 120 kg of raw cotton per hour producing about 40 kg of gin cotton per hour, power requirement 3½ to 4 hp.

Estimated cost	$1,500

1—Electric baler—capacity about 4 to 5 bales and 120.kg each per hour, requiring 3 to 4 hp.

Estimated cost	$2,400
Total estimated cost	$3,900

Workshop machinery

1—Drilling machine—drilling capacity 30 mm. with slotted baseplate using 1 hp motor

1—Precision lathe—170 mm centre, lenth of bed 2 metres, requiring 1½ hp motor

1—Hack saw machine, requiring 1½ hp motor

1—Smithy forge to be built locally complete with motor driven blower, requiring 1½ hp motar (local currency)

1—Electric arc welding machine, capacity about 300 amp. driven by electric motor

1—Gas welder—complete oxy-acetylene welding equipment (local currency)

Total estimated cost	$3,710
Plus local currency	$800

Cold storage and ice making machine

1—Complete ice making plant with a capacity of 5 to 6 tons of clear ice of 100 lb size per day, and a cold storage of approximately 10 tons capacity at a temperature range of 15° to 28° F (—9° to 2° C), requiring 30 hp motor for the ice plant and 10 hp motor for the cold storage.

Estimated cost	$15,000
Plus local currency	$5,000

Electric pump

1—Portable electric water pumping set mounted on a trolley with 5 hp motor to pump water against a total head of 10 meters.

Estimated cost	$1,000
Total cost foreign currency	$51,544
Total cost local currency	$5,800
	$57,344

(*Note prepared by the ECAFE. Subcommittee on Electric Power*)

(*Continued from page* 26)

Dry Chemical Feeder

The Paterson Dry Chemical Feeder

ensuring uniform gravitational descent to the feed table. The measured stream of chemical is discharged through an opening into the vortex mixer adjoining where it is intimately mixed with water and discharged to the point of application.

The rate of feed is externally controlled by the rotation of a small friction hand-wheel mounted above the vortex mixer which moves the feed knife further into or out of engagement, the position of the knife and consequently the rate of feed being shown by a pointer on a divided scale. The worm drive of the knife and pointer ensures positive fixed adjustment without the necessity for a locking device or the setting of fixing means such as locknuts or set screws, and there is also included a device for adjusting and locking the knife thickness. Also by modification of the speed reduction gear any required delivery can be secured from a few ounces to several cwt. per hour.

The feeder is practically dust-tight in operation, the feed hopper being fitted with a dust proof cover prevent light materials being airborne by stray air currents and becoming deposited on bearings of motors and other machinery.

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If necessary an accurate check on the weight of material discharged by the feeder during any given period of time may conveniently be obtained by mounting the feeder on a weighing machine of the platform type.

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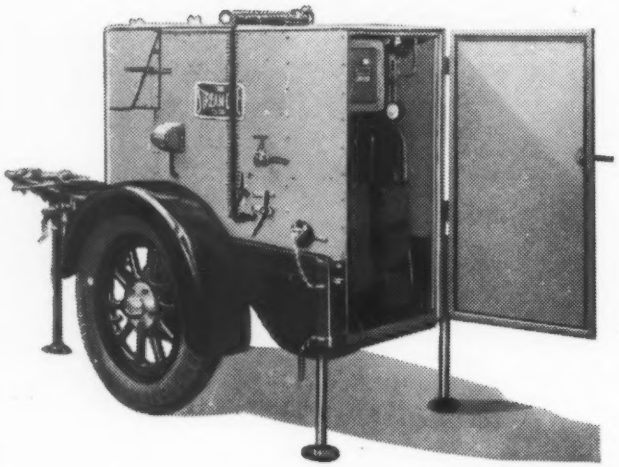

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SPHERICAL ROLLER BEARINGS IN RAILWAY AXLEBOXES

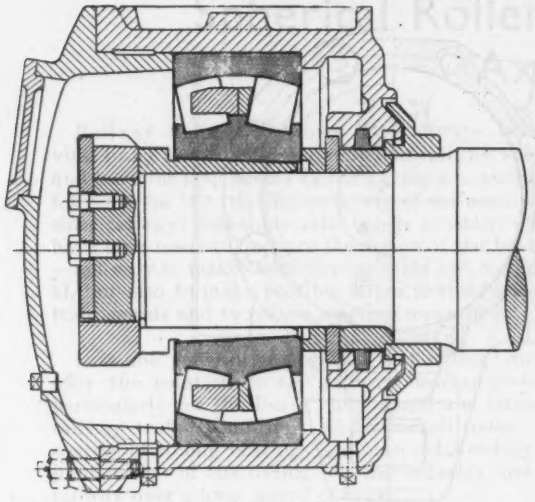

Fig. 1. Axlebox for heavy American passenger bogies installed in 1921.

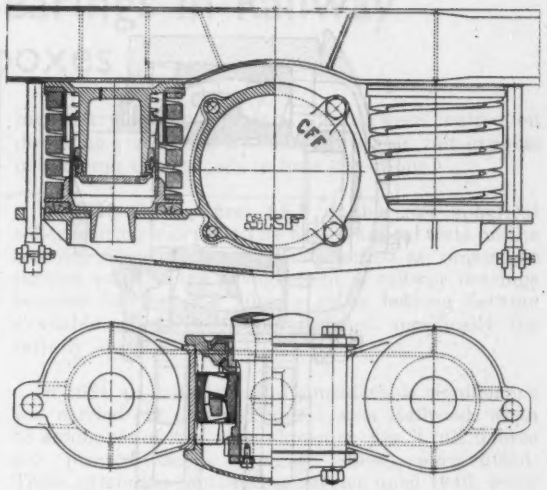

Fig. 4. Bearing scheme of Swiss Schlieren bogie. The axlebox is fitted with one spherical roller bearing

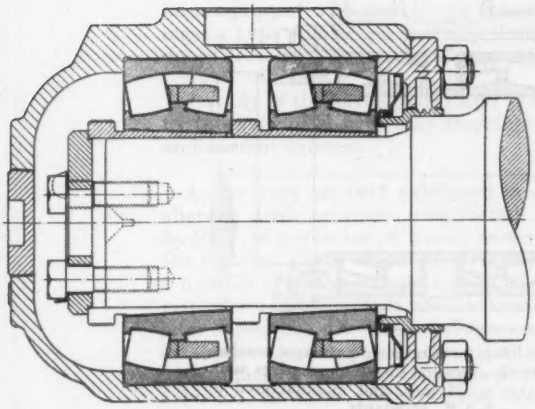

Fig. 2 Roller bearing axlebox fitted with two spherical roller bearings for four-wheel goods wagons.

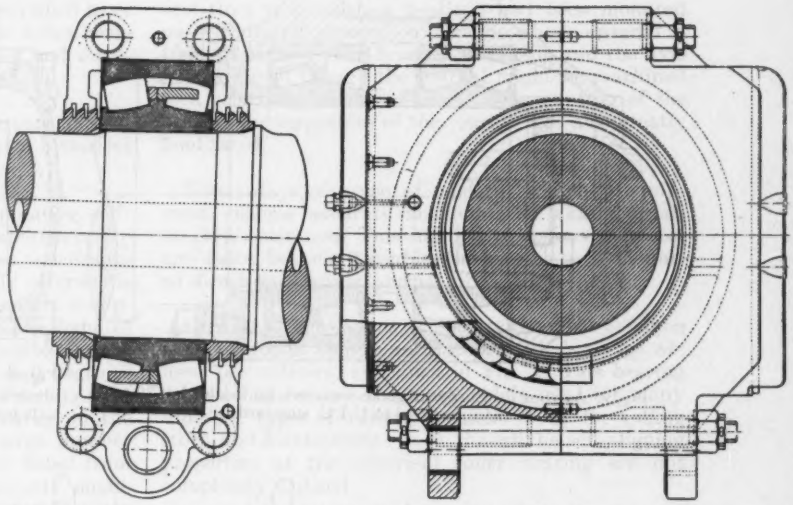

Fig. 5. Single bearing axlebox for the driving and coupled axles of steam locomotives.

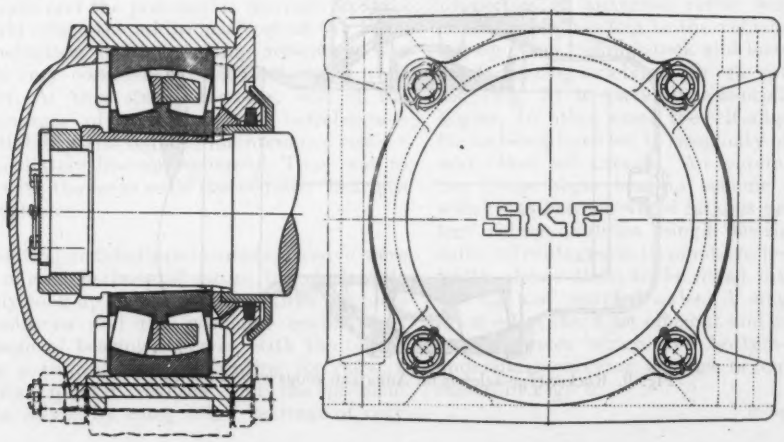

Fig. 3. Completely self-aligning axlebox for diamond bogie of locomotive tender

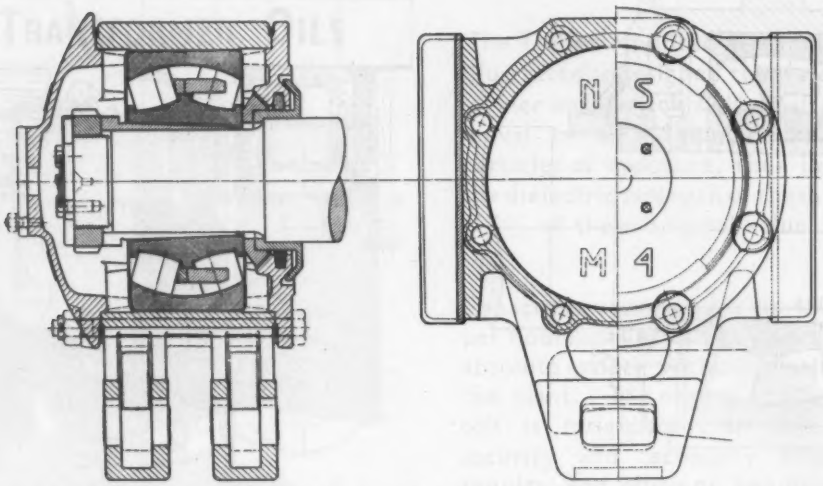

Fig. 6. Axlebox with load carried by an underslung equalizing beam for motor bogie of Dutch multiple unit stock

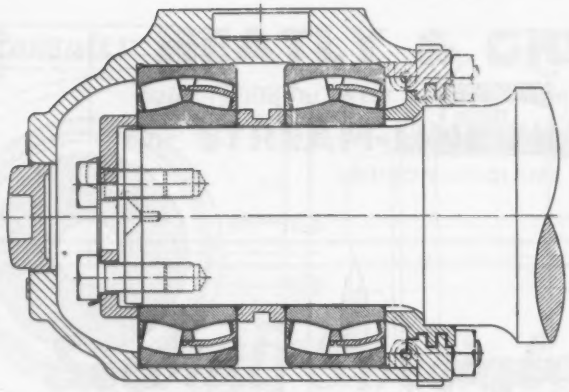

Fig. 7. Axlebox for European goods wagons with axleload of 20 tons, manufactured to U.I.C. standards.

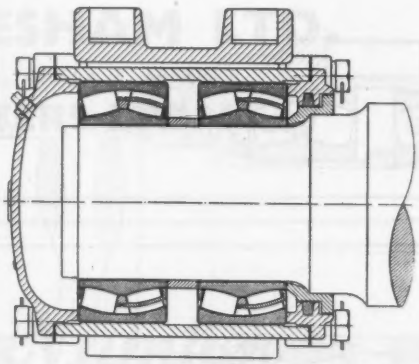

Fig. 8. Axlebox for American passenger coaches, electric locomotives and diesel locomotives with axle loads up to 24 tons, and manufactured to A.A.R. standards.

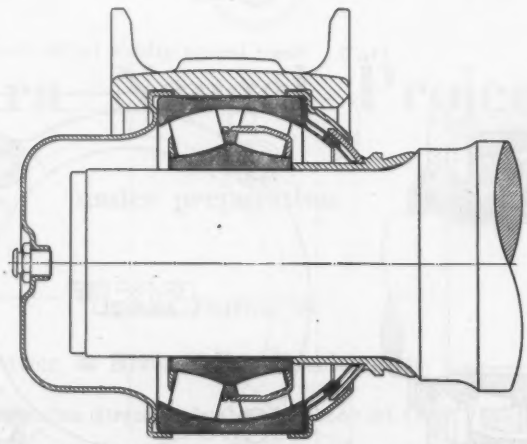

Fig. 9. Rocker-type axlebox for American goods wagon bogies.

Spherical Roller Bearings in Railway Axleboxes

Railway axlebox bearings have always been of vital importance to the reliability of railway vehicles and have for long been a factor having a considerable influence on the running economy of railways. Ever since railways first came into being, constant efforts have been made to improve the design of the bearings —not only to make them more reliable and economical, but also to make possible larger payloads, higher train speeds and to reduce starting resistance.

It is now generally recognised that rolling bearings offer the solution to the railway bearing problem, particularly for the heavy, high-speed and intensive railway traffic conditions which prevail today. The success of rolling bearings has been achieved by the joint efforts of the rolling bearing industry and the railway over a long period of years.

Special interest is centred on this matter at the present time because SKF has just announced the supply of the millionth SKF axlebox. The vast majority of the million axleboxes so far supplied have been equipped with double row spherical roller bearings, a type which was specially designed and introduced to solve railway bearings problems.

A study of the development and of the part played by this type of bearing may therefore be of historical and current interest.

As far back as 1911 axleboxes incorporating self-aligning ball bearings were fitted experimentally by SKF to a number of heavy passenger coaches on the Sewdish State Railways, and shortly afterwards a number of steam locomotives were similarly equipped. For reasons which are obvious in the light of later experience, the restricted space available for the axleboxes did not permit the fitting of ball bearings with sufficient carrying capacity. Better results were achieved, however, with 6-wheel ore trucks on the North Swedish ore railways, to which a large number of ball bearing equipped axleboxes were fitted from 1915 onwards. Extensive examinations were made, however, of the train resistence compared with plain bearings equipped trains, which proved that the saving in power and the permissible increase in train lengths would offset the additional cost of the bearings. The reduction in the starting resistence was found to be very considerable, particularly in very cold weather. At this stage, however, one of the major advantages of rolling bearing axleboxes— increased reliability and reduced maintenance costs— did not immediately become apparent. That was to follow later with the large scale use of roller bearings in railway vehicles.

The ball bearing installations mentioned above were very largely of an experimental nature, but meanwhile SKF seriously took up the question of railway vehicle working conditions and the problems encountered with the design of bearing schemes, with the object of producing a suitable type of bearing for railway service. It was quickly realised that the problem could only be solved by using roller bearings of very high carrying capacity, and efforts were centred on designing a self-contained non-adjustable unit capable of carrying thrust loads in both directions.

In 1919-20, the first SKF double row spherical roller bearing was put to its first practical tests on the Swedish State Railways. This marked an important turning point in the development of railway bearings because for the first time a roller bearing became available which had been designed specifically for railway service.

In 1921 an installation of considerable significance was carried out on the Pennsylvania Railroad, when 48 axleboxes of the type shown in Fig. 1 (all figures are printed on a seperate sheet) were fitted. These axleboxes remained in service until 1946, when the coaches were scrapped. The design of this axlebox is of special interest because it was the first time that a single, completely self-aligning bearing had been used successfully in a railway axlebox. It was also the first time that axlebox bearings had been mounted on withdrawal sleeves—a feature which ensured a tight fit between the bearing inner ring and the axle journal, even though the journal might be machined to a relatively coarse tolerance. Dismounting of the bearing for inspection of the journal was also greatly facilitated.

Now-a-days, the use of modern workshop equipment ensures accurate machining of axle journals to close tolerances This has led to a saving in cost and space, because it enables the bearing to be mounted direct on the axle journal.

On four-wheel wagons, which are the most common type of goods vehicle in Europe, two bearings are used per axlebox, as shown in Fig. 2. This bearing scheme has become the most widely used for many different types of railway vehicle—both for rolling stock and locomotives—even though the self-aligning properties of the spherical roller bearing are not completely utilised.

In many cases, however, the unique self-aligning properties of spherical roller bearings have given considerable freedom to the vehicle designer in drawing up bogie, rolling stock and locomotive designs. A single bearing axlebox with one spherical roller bearing (Fig. 3) is virtually essential in diamond-type bogies. In other cases the self-aligning properties of the axlebox have led to simplicity of design, flexibility and other advantages. An outstanding example is the Swiss bogie bearing scheme shown in Fig. 4, which has become world famous because of its excellent riding qualities. Single bearing axleboxes also suffer advantages on locomotives because their narrow width allows them to be fitted inside the wheels on driving and coupled axles. A single bearing design often offers the most efficient and economical solution for axleboxes which are bottom-loaded either by underslung carrying springs or equalising beams as shown in Fig. 6.

(*Continued on page* 20)

Research Awards by Central Board of Irrigation and Power

The Central Board of Irrigation and Power has instituted merit certificates to be awarded to individuals and research stations for the best contributions each year. This is in addition to the Gold Medal to be awarded to outstanding work in research and invention.

At the 26th annual meeting of the Board in Delhi Dr. R. C. Hoon and Shri R. K. V. Narasimham were awarded merit certificates for individual contributions and the Hirakud Research Station for the best group contribution during the year.

Dr. Hoon

For purposes of agricultural development a vast land area in India has got to be classified into precise categories depending upon the structure, fertility and a number of other characteristics. Dr. R. C. Hoon, Director, Central Water and Power Commission, who was till recently incharge of Hirakud Research Station, was awarded a certificate of merit for his paper on 'Productivity Rating of Soils'. It has broken new record on the field of agricultural practice and is forerunner of more research on this important subject. He has attempted in his paper to rate the soil classification in six classes on analogy of the system in vogue with the Bureau of Agriculture in U.S.A.

Shri Narasimham

Shri R. K. V. Narasimham, Research Officer, Hyderabad Engineering Research Laboratories, was awarded the certificate for his paper on Energy Dissipators presented at the Symposium held at Srinagar in July 1955. The devices of "interacting jets" evolved by him is considered very ingenious and effective.

The invention worked out by Shri Narasimham has great possibilities of practical application and substantial economy in the design of spillways of dams. The principle of the device is easily understood. The surplus water overflowing the spillway from the reservoir comes down with an enormous force and, if uncontrolled, would cause considerable damage at the foot of the dam downstream, threatening the river channel.

Shri Narasimham simply thought of using force against force to nullify destructive momentum. He has worked out a way of splitting the overflowing mass of water into a number of dual streams. Each stream, impinging against its twin at the foot of the dam, reduces itself to a de-energised inocuous mass of water.

Hirakud Research Station

Enormous quantities of cement concrete are used in great variety of structures including dams and other irrigation and power works. It has been found that inclusion of non-coalescing microscopic bubbles of air in cement concrete improves the workability of the medium, which is a great factor in the construction of structures. To achieve this object a large number of patent commercial products have been developed.

The Hirakud Research Station is the first in India which took up the superiority of Vinsol Resin NVX over all other proprietory products for the conditions obtaining at the Hirakud project. The research staff of the Station under the guidance of Dr. R. C. Hoon, devoted their attention to the development of suitable admixture from indigenous products. The Station succeeded in developing a very satisfactory air-entraining agent which has been named Aerosin HRS. This agent is now being employed for the concrete used in the Hirakud dam.

A certificate of merit has been awarded by the Board to the Research Station for this work.

Dry Chemical Feeder

The "R. T." feeder of the Paterson Engineering Company Ltd, is an interesting apparatus used by boiler engineers for water treatment especially where river water is being used for process work.

It is suitable for use with the following materials :— iron oxide, copper sulphate, activated carbon, gypsum, powdered starch, sulphate of iron, etc.

It is interesting to note that the only moving part of the machine is the revolving feed table, rotated at constant slow speed below the stationary feed hopper.

This rotation is effected by an electric motor, Pelton wheel or convenient belt drive, with the necessary speed reducing gear.

A sectional feed knife extends into the chemical or other product within the base of the hopper, deflecting a certain constant volume of materials from the table into a vortex mixer alongside, the quantity deflected being determined by the position of the feed knife and the number of sections of the knife which are in the operative position. The effective thickness of the knife is pre-determined according to the required range of feed capacity, the range being very wide while the position of the knife is instantaneously adjustable by a positive external control while the machine is running.

When used for reagents having a tendency to arch or pack, moving agitators are provided within the feed hopper keeping the mass of chemical in motion, and

(*Contiuued on page* 23)

Our Delhi Letter

(From our own Correspondent)

The annual meeting of the Institution of Engineers (India) took place in the coloured and picturesque surroundings of the rapidly growing capital of the Punjab at Chandigarh. In more senses than one, this meeting will be remembered as a milestone in the history of this important organisation. The engineers stated here, for the first time in unequivocal language. that the leadership in the process of the country's development should now belong to the Scientists and the Engineers rather than the law and order Administrators. It was also mentioned that unless this was done it would be quite impossible to cope with the rapid pace of development which was needed under the second Five Year Plan programme.

This statement was made in a forthright manner by Professor M. S. Thacker who presided over the deliberations as the President for the ensuing year. He quoted no less an authority than Pandit Nehru himself in support of this thesis. Science and technology were now the determining factors in the destiny that humanity is carving out for itself. All planning and decisions have consequently to be made in the Laboratory and the Design office rather than in law courts. The Lawyer and the Politician no doubt flourish in hair-splitting analysis in disputes over territory and between conflicting humanity. But it is admittedly the field of the Engineer, Scientist, Manufacturer and Economist to produce more of the World's goods and accessories to make life easier and fuller by the banishment of poverty and drudgery. And for this purpose the initiative must completely belong to the Technologist. After all, administrative improvements can do some good only if the technical feasibility and merit of an Engineering Project are beyond doubt.

Controversy about Secretary's Powers for Heads of Departments

Inspite of the above axiomatic truth one continuously hears the controversy about Heads of Technical Departments not being made Secretaries to Government. The argument raised is that technical people are too much immersed in the technical details of their projects and they have not the aptitude to view the problems with the angle of the laymen or the politician. It is also said that there have been certain cases of mal-administration in some departments where the Heads are Scientists or Engineers. Both these arguments are quite unrealistic because the calibre and personality of the selected individuals comprise the main criteria which govern success or failure. It will however be readily conceded that the instances of inefficiency or corruption are not limited only to the departments in which Technicians are olso Secretaries. In fact the evil is more of a national problem and it will not be correct to use this argument for depriving a technical head of Department from wielding Secretary's powers. It can be stated without fear of contradiction that however a fast schedule of construction has to be followed, responsibility of adhering to the targets can never be divorced from the powers to enforce administrative decisions. The above will apply to Engineering and Scientific Departments as much as to any other departments in which policies have to be framed and implemented. Technology and Research can not progress where the men in the laboratory or the workshop have to look to some one else than their technical heads for small mercies or encouragement. At present the Punjab Chief Engineers are also Secretaries to the Government. In Bombay recently the Chief Engineer has been additional Secretary. The Director of Scientific and Industrial Research has also been made Additional Secretary. For the Second Five Year Plan it is imperative that no retrograde move is accepted.

Irrigation and Power Projects in Second Plan

In the second Five Year Plan Irrigation and Power Projects have again received high priority. The provision for Railways and Transport is no doubt, about 50% bigger but we have to bear in mind that the collective sum of the First and Second Five Year Plans is much bigger for Irrigation and Power than for Railways. Except the provinces covered by the Bhakra Nangal Project, expenditure during the First Plan has been rather backward in other provinces. This is due to the fact that a lot of spade work had been done in the Punjab prior to 1951. This has enabled the First Five Year Plan to be implemented with greater finality. The personnel position in the Punjab was also somewhat better than in other States. They were not only greater in number but their experience both in the office and the field was bigger. The Planning Commission and the Government of India were both aware of this fact and they loaded the existing staff to their optimum pitch and measured out their allotment of funds and resources accordingly. Thus the Punjab Project has gone ahead and it has already become a by-word in the country for economic advancement through irrigation and power facilities. In the Second Plan, the experiences gained in the first plan will be utilised to greater advantage. Many of the hurdles and pit falls of the first five years will be no doubt avoided in the Second Five Year Plan. For this purpose there must be full facility for dissemination of information and constructive criticism. A genuine desire to effect improvement must also be fostered amongst all ranks, so that the momentum in favour of improvements builds up to ensure worthwhile results.

Construction Corporation

The idea of the Construction Corporation seems to have gone into cold storage. Judging from the progress that was made in the coordinating Board of Ministers' meeting last year, one would have hoped that further implementation of the idea will not be long delayed. But the sense of urgency seems to have worn of rather prematurely. Yet the tempo of execution of projects must not be allowed to lag. Departmental construction by the various States is bound to be a process of painful experimentation. It is therefore high time that the Centre should take further initiative and invite the State Governments to lay their cards on the table and then ensure that the programmes framed are realistic and progressive. This process need not entail any undue sacrifice of patronage on the part

of the State Governments because the volume of work is sufficient to warrant its splitting up into the public and private sector. The guiding principles in such cases should be the efficiency of the arrangement. A demarcation will not be difficult at all if the private sector is loaded upto capacity and the balance of the work is allocated to the public sector. In this way a healthy competition will be set up and the project will be completed on schedule, thus reducing the overhead expenditure and expediting the achievement of the larger benefit contemplated in the project. The private sector should keep itself in a proper condition to execute the proportion of the work allotted to it. Thus its turns over will be rapid. Even if the profit goes down in percentage due to healthy competition, the total income to the private sector can remain undiminished because of the vaster quantity of work that can be handled by it due to the removal of uncertainty. It is hoped that this subject would produce a fit forum for the expression of views and suggestions, so that the forces of opposition become relatively weaker and a corporation envisaged in the deliberations of the Seminar of Engineers becomes an accomplished fact. It is the start of such an idea that is difficult rather than its subsequent operation which will follow automatically.

It will not be out of place to mention that there are certain very well recognised facts which have a bearing on the issue. These are given below ;

1. There is definitely room for such an organisation if the works have to be of high quality and if the completion targets are not to be delayed

2. It will take some years before private contracting organisations can rise upto the stature of a Government sponsored organisation.

3. In the present system the initiative for small decisions even, has to come from the top.

4. The maximum good that this organisation will do is of course in the realm of machinery. Once it is settled that all the serviceable machinery in River Valley Projects is to be looked after, serviced and repaired for the next job, there will be greater attention paid to this aspect.

Bhakra Dam and Kotla

Bhakra Dam construction is now in its spectacular stage. Day after day huge cranes are laying bucket-full of concrete into final position. Each bucket contains 4 c.yds. (roughly eight tons) of mixed concrete. These buckets are swung into position by giant cranes which are mounted at site on strategic points. The stilling pool section of the dam is nearly completed and further erection of trestles is in progress. One trestle is 320 feet high above its foundation level. When you see the workmen climbing this trestle for completing the track they appear like little monkeys climbing the awkward branches of a giant tree. Their courage and presence of mind are praiseworthy and the example is worthy of emulation by other workers on similar job. After all, it is the situation and the work itself that teaches. There is every reason for confidence that mechanised jobs will become more popular in this country with every additional project that is undertaken.

The Kotla Power House on the Nangal Canal is being completed one month ahead of schedule. Its inauguration may now be confidently expected by the middle of the year. With its two units of 2,400 kWs., it will nearly double (24,000) the generation from Nangal Power House and there will be a better prospect for some of the consumers in Delhi who are now waiting in the queue even for a single kilowatt of power. With the air-conditioning load moutning up, it is now already being loudly mentioned in knowledgeable circles that the total load of Delhi will be in the neighbourhood of 100,000 k.Ws. rather than the 10,000 k.Ws. — the figure that had been quoted for so many years. That brings out the urgency of the completion of the Bhakra Power Plant not only on the left side but also on the right side. In this case, the experience of the past for greater generating capacity will be borne out even more strikingly.

United Nations Technical Assistance Board

The visit of Mr. Owen, Executive Chairman of the Technical Assistance Board, of the United Nations, is worthy of mention as it enabled a discussion of the scope and success of some Engineer-Specialists who have been detailed to India for various technical programmes. During discussion with him and with Mr. Goldsmith of the same organisation, it was gratifying to learn that the Indian Programmes have produced a definite impression of real progress on these important visitors. Both Mr. Owen and Mr. Goldsmith were in search of some suitable Indian Engineers, who can be recruited under U.N.T.A.A. for work in other countries.

DVC and the Government

The Damodar Valley Corporation is the only autonomous statutory authority in India in charge of a multi-purpose river valley project, although a large number of such projects are under execution in the country. But its history ever since its creation in 1948 has been full of vissicitudes. Only this month there has been another attack on the DVC by one of its "partners", namely, the West Bengal Government. Dr. B. C. Roy, the Chief Minister, declared in the State Assembly that "we have no power, direct or indirect, except by suggestions and recommendations, to control the activities of the Corporation although we are asked to pay a large sum of money". "I haved tried and I am still trying to protest against the iniquitous nature of this (DVC) Act." "It would be better if the Central Government take it up altogether and relieve us of the burden of the advances made to us."

Until now the public had the impression that it was only the Central Government which interfered with the autonomy of the Coporation. Now we are told that even one of the State Governments also desired to interfere with it. As we read the situation, the DVC is today autonomous only in name. If that really be the case, is it not far better to be honest about it and scrap the statute and make it a government department or an *ad hoc* Board, as is the case with other river valley projects? We have stated time and again that if DVC is to be an experiment in antonomous authority it should be allowed to develop fully in that manner. But if such an experiment is not desired, let the DVC close down. The Centre has not been feeling happy about it. Now one of the States has clearly expressed its mind. It is, therefore, time that the country makes a fresh re-appraisal.

It appears there is an indirect policy of emasculating the DVC. As Mr. P. P. Verma, the only continuing member of the DVC, has pointed out in his article in our DVC Special Number (Vol. V, No. 6), the scope of the Corporation's activities is now severely restricted. Now, after the first phase of the Project is nearing completion, the DVC is finding that the second phase is not included in the Second Five-Year Plan. The DVC is, therefore, faced with the perspective of its own unemployment except as bulk distributors of power and water to the two State Governments. Is such a situation merely accidental ?

When a DVC Enquiry Committee was appointed, it reported that the semi-autonomous authority system is very suitable to the administration of multi-purpose river valley projects. Was this view accepted by the Central and State Governments? If not, what were their views? Even so, what are their views on the subject today? Is it not time for them to take the public into confidence?

The Second Plan has devoted a whole chapter on the subject of administration. But this issue has only barely been mentioned. But the programme of river valley projects is not a short term one. It is, therefore, opportune that the Central Government initiates a public discussion on the issue without any more delay by laying down its own thoughts and conclusions based on past experiences. This is not an issue which can be properly resolved in an atmosphere of seclusion and privacy.

But so long as the Government is committed to an experiment with autonomous authority, we ask it to be fair and straight and to observe that the DVC grows and functions as such. Now that Mr. P. S. Rau, the Chairman of the DVC, has taken up another responsibility, we would like the Government to nominate an outstanding publicman in his place, so that the DVC publicly enjoys a prestige of autonomy and thus removes the impression so far created that for all practical purposes it is only an extension of the Central Government's department.

We have argued on several occasions that the concept of partnership is the root of much of the trouble in the DVC. Now our worst fears have been confirmed by Dr. Roy's statement. It should be noted here that in the TVA Act no such conception existed and yet there has been little difficulty between the TVA and the seven States. It is this aspect that needs a thorough review and, while the DVC Act seriously needs amending, the more important thing is to realise that experiment in autonomy needs a more tolerant and understanding frame of mind among legislators and ministers, to be applied in actual practice.

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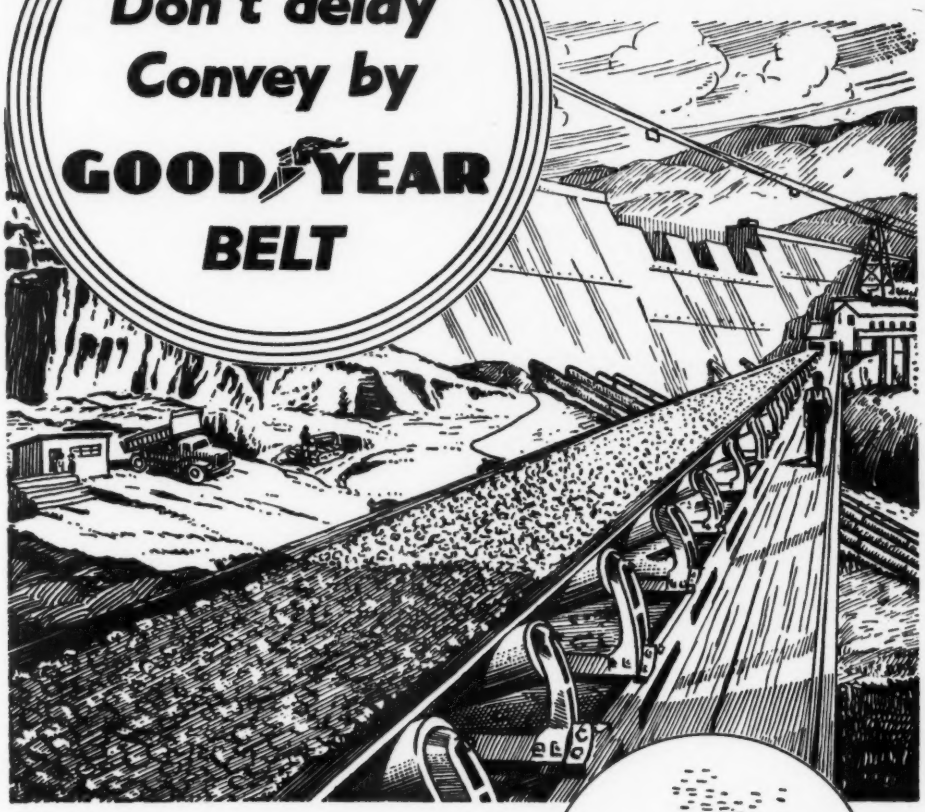

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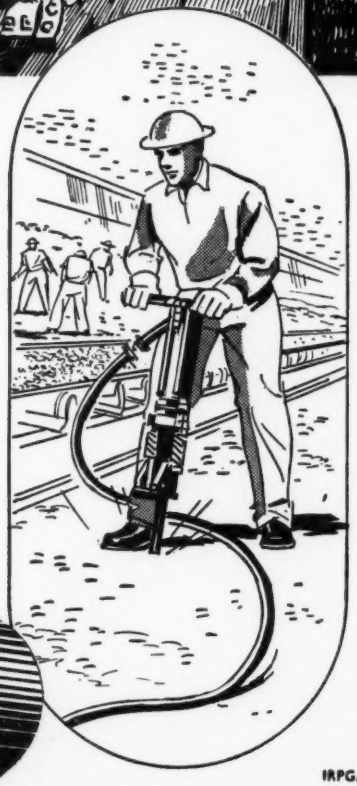

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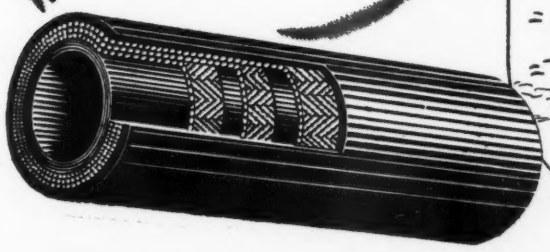

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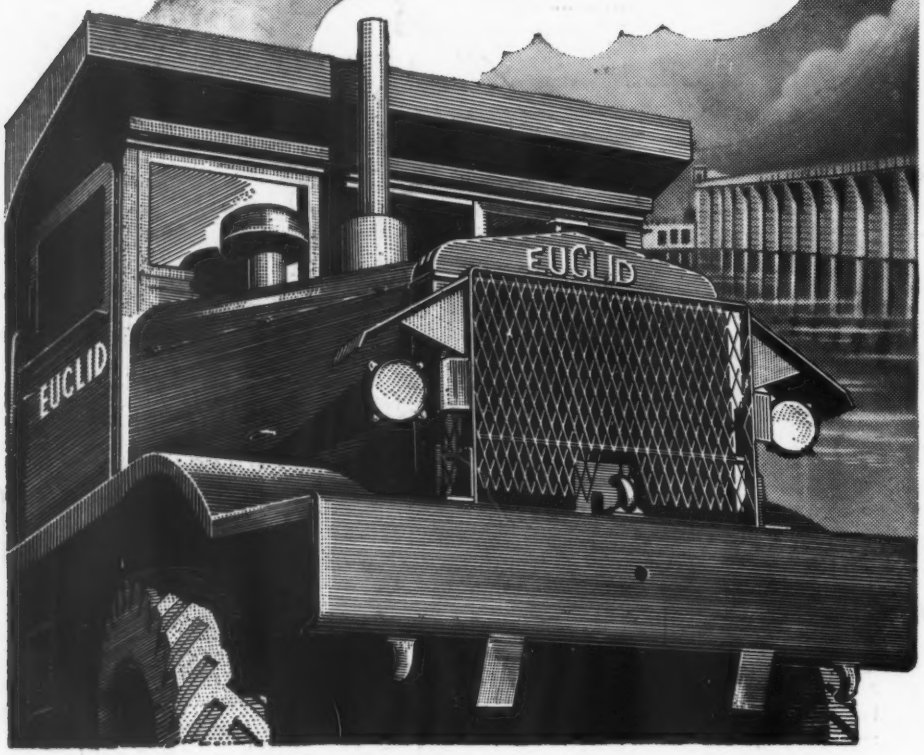

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